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BOMBAY NATURAL HISTORY SOCIETY

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A Struggle for Survival

IN 1936, the then Curator of the Society, the late S.H. Prater, did a survey of the tigers shot under licence by sportsmen in the districts ruled by the British and in the Indian states ruled by Maharajahs. The harvest, if one may use such an expression, came to approximately a thousand tigers shot both with and without licence. There is no evidence to believe that this "harvest" affected the population of tigers. The forests were extensive in area, largely contiguous and the population of tigers was abundant wherever optimum conditions prevailed and this was the case in the majority of tiger habitats. Poaching was negligible and poisoning non-existent, as the deadly pesticides which are now in common usage were not available. It can be assumed that a similar number was being killed in subsequent years without a noticeable change in the population structure of the species.

Conditions changed with Independence. A large area of forest was converted into agricultural land, and forests where they existed were degraded. Hunting as a sport degenerated into trophy hunting without ethics, and with the free availability of weapons poaching proliferated. New chemical pesticides, deadly in effect, provided an easy method of eliminating troublesome predators on domestic stock, which replaced the wild herbivores already poached to local extinction.

At this point of time, realisation dawned that the tiger would be extinct before the end of the century if not protected absolutely. Project Tiger came into existence to protect the species in identified tiger habitats and the emphasis was on numbers, with little thought of contiguity of habitat, dispersal corridors, prey levels and the interests of the surrounding human populations in the survival of the tiger. The capacity of the Field Director was judged by the number of tigers that his tiger reserve was said to hold.

At the end of the century, we have 25 isolated tiger reserves beset with the problem of poaching for commercial use of tiger parts, reserves largely surrounded by hostile human populations antagonised at being denied traditional benefits they had taken from the reserves and the belated realisation that unless the people in the surrounding villages and those living within the protected areas co-operate, there is no future for the tiger.

How long the tiger will survive in the new millennium depends on how intelligently the problems facing its survival are managed. Judging from the present, the future is bleak.■

Cover photograph: Tiger in Sundarbans
Sudheer Agashe

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POPULATION ESTIMATION OF ASIATIC LIONS[1]

YADVENDRADEV V. JHALA[2,4], QAMAR QURESHI[2], VIMAL BHUVA[3] AND LEKH NATH SHARMA[2]

(*With seven text-figures*)

Key Words: *Panthera leo persica,* mark-recapture, individual identification, Gir lions.

Applicability of vibrissae spot pattern for individual identification of Asiatic lions *(Panthera leo persica)* was validated in wild and captive lions. We used computer simulation models to work out the applicability of the Lincoln-Peterson model and its sample size requirements for varied population sizes. The model recommended marking over 30% of a hypothetical population of 250 lions to obtain a desired level of accuracy (CV < 20%) for estimating population size. An appropriate experimental design was then developed for such a census in Gir National Park and Sanctuary. The vibrissae technique was utilised for individual identification of 80 wild lions in Gir for conducting a mark-recapture census. The Peterson population estimate of lions (excluding cubs < 18 months) in Gir was 222. The standard deviation using Chapman (1951) estimator was ±54.5 lions. A separate analysis of the male and female populations estimated 74±17 males and 167±67 females. We also estimated the mean (201 lions) and standard deviation (±23) by a modified Jack-knife technique. The Forest Department of Gujarat concomitantly conducted a labour intensive *total count* of lions using bait for over three days. The *total count* of lions in Gir National Park and Sanctuary (excluding cubs) was 94 males, 110 females (204 total). Analysis of past several years census data suggests that the lion population in Gir has been increasing with an r = 0.022 ($P<0.001$, $R^2=0.96$). We recommend the use of the vibrissae identification method as a tool for monitoring, estimating populations, and to develop more sophisticated models for evaluating survival and movement of lions.

INTRODUCTION

Population estimation of wide ranging carnivores has always been a challenge to wildlife managers. Several approaches have been tried for estimating large carnivore numbers. These include pug-marks (Das and Sanyal 1995, Gore et al. 1993, Panwar 1979, Smallwood and Fitzhugh 1993, 1995), track counts (Palomares *et al.* 1996, Van Sickle and Lindzey 1991), scent-plots (Knowlton and Tzilkowski 1979), mark-recapture (Garshelis 1992, Karanth 1995, Karanth and Nicholes in press), radio-telemetry and intensive study in small areas, densities of which are then extrapolated to estimate total population (Fuller 1989). In case of endangered carnivores, population estimates need to be precise and accurate, since a small decline in such a population could prove disastrous (Taylor and Gerrodette 1993, Caughley 1994). Methods for

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censusing endangered carnivores need to be practical and cost effective with regard to prevailing socioeconomic conditions of the region.

Tiger *(Panthera tigris)* census in India is done using the pug-mark technique (Choudhury 1970) whose accuracy and precision were questioned (Karanth 1987). Karanth (1995), and Karanth and Nicholes (in press) have used camera traps to estimate tiger numbers within intensive study areas in tiger preserves. Objective, accurate and precise census techniques for large carnivores are urgently needed. In this paper, we evaluate the available data on Gir lion populations and currently used census technique, and demonstrate the use of sighting-resighting population estimation (Pollock *et al.* 1990) as an alternative for monitoring and estimating numbers of the last remaining population of Asiatic lions in the Gir Forest of Gujarat, India. The sighting-resighting estimate of lions in Gir was done concomitantly with the five-yearly *total count* of lions that is conducted by the Gujarat Forest Department (Singh 1995, 1997). This provided a unique opportunity to compare the statistical estimates obtained by the mark-recapture technique with the *total counts* as a point estimate.

Methods

Total Counts of Lions

Since 1963, the Gujarat Forest Department has estimated lion numbers in Gir about every five years. For the 1995 census, lions were baited with live domestic buffaloes for three consecutive days throughout the entire lion range (over 1,800 km^2). Over 250 buffaloes were used and about 1500 man-days consisting of forest staff and volunteers were employed in conducting this massive census operation. Most lions in Gir were used to killing livestock and readily took buffalo bait. A daily record was kept of all lions that fed on (or visited) the baits. After accounting for possible double counts, the maximum number of lions recorded on any single day was considered to be the total population.

Precision of Population Estimates

Judging from the Forest Department records for the past several years, we speculated that the lion population in Gir was close to 250 individuals. We modelled a scenario wherein a population of 250 lions was declining at a rate of ten percent per year. Since there was no way of estimating accuracy or precision of the *total counts* reported by the Forest Department, error bars with these estimates could not be generated. Population estimates for large cats having a coefficient of variation less than 20% are difficult to achieve in wilderness areas (Karanth 1995, Karanth and Nicholes in press, Smallwood and Fitzhugh 1995). To evaluate the effect of precision and time intervals between consecutive counts on the practical utility of population estimates, we generated 95% confidence intervals on the modelled population estimates using a coefficient of variation of 20%. We compared 95% confidence intervals on subsequent population estimates to determine if the estimates differed.

Individual Identification of Lions

Pennycuick and Rudnai (1970) developed a technique for identifying individual African lions *(Panthera leo leo)* based on vibrissae spots. Further, they calculated levels of probability of encountering another lion with the same vibrissae pattern within a given population.

The vibrissae spot method is based on variation in the spot patterns of the top row (row A) of spots with reference to the second row (row B) of spots (Fig. 1). For a detailed description of the technique see Pennycuick and Rudnai (1970). We collected data on vibrissae patterns of 40 wild and 34 captive Asian lions with the aid of a 15 to 30X spotting scope and occasional photographic records using a 300-500 mm lens. Spot patterns were recorded on graph paper (Fig. 1) where each square provides a potential

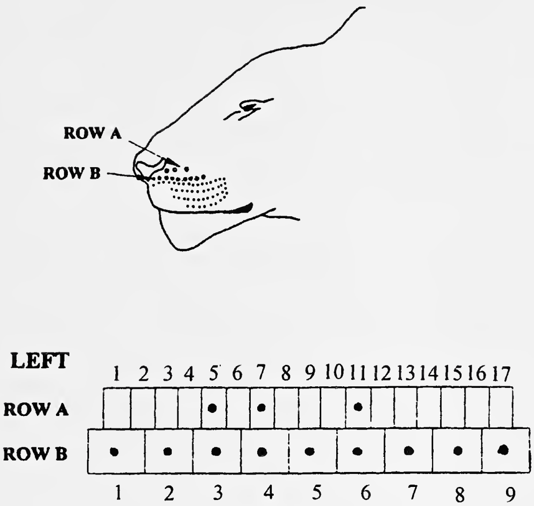

Fig. 1 : Left profile of a lion showing whisker patterns used for individual identification. Graphical representation of the same pattern is presented below (after Pennycuick and Rudnai 1970)

location of a spot in Rows A and B. Thus Row B could possibly have a maximum of 9 spots, while row A could have a maximum of 17 spot positions.

Data on the location of the lion, age group, sex, pride composition, and any additional identifiable marks on the body like notches in the ear, and permanent scars were recorded. The above data from Asian lions were analysed to test the validity of the assumptions of the method and reliability of unique identification.

Sight-Resight Population Estimation

Sight-resight population estimate is based on the Lincoln-Peterson model (Pollock *et al.* 1990). The model is based on 2 capture (sighting) sessions: (i) Sighting and individual identification of a random sample of lions (nl). (ii) Subsequent sighting survey, wherein another random sample of lions is identified (n2) and within this sample, lions that were also sighted in the first survey are counted as "recaptures" (m). The model has several assumptions that need to be satisfied to estimate lion numbers without bias and with good precision:

(i) Geographic and demographic closure of the Gir lion population, (ii) correct identification of each lion with no mistaken identity and (iii) all lions must have the same, independent probability of being sighted (Otis *et al.* 1978).

Population estimation (N) is based on the principle of dilution:

$$N = \frac{(n1\ n2)}{m} \quad \text{..........equation 1}$$

An unbiased estimate of N is obtained by (Otis *et al.* 1978):

$$\tilde{N} = \frac{(nl + 1)\ (n2 + 1)}{(m+1)} - 1 \quad \text{........equation 2}$$

and its variance was estimated as (Chapman 1951):

$$\mathrm{Var}\ \tilde{N} = \frac{(nl+1)\ (n2+1)\ (nl-m)\ (n2-m)}{(m+1)^2\ (m+2)} \quad \text{..........equation 3}$$

where nl = sample of first sighting and identification
n2 = sample of second sighting and identification
m = number of lions from the first sample (n1) that were again sighted in the second sample (n2) (resighted).

Since we included the entire Gir Forest (National Park and Sanctuary) covering an area of over 1400 km^2 as our study area, the population could be considered as geographically closed. Two small lion populations have been established outside of the Gir Reserve after 1990 by dispersing lions (Singh 1997). These were in Girnar numbering close to 10, and the coastal forests of Kodinar numbering approximately 20 lions. Movement between these populations and the Gir protected area could not be ruled out. Even if such movements did occur during the course of this study, the numbers involved would be quite small.

Session 1, marking lions, effectively lasted for six months in the summer and winter months of 1994. The second session was of a much shorter duration of 18 days and coincided with the total count exercise conducted by the Gujarat Forest Department in May 1995. The two sampling sessions were spaced about 10 months apart. Inevitably some mortality of the marked lions would have occurred in this time frame and affected the precision of our mark-recapture estimate. Since mortality was likely to be greatest amongst young cubs (Ashraf *et al.* 1995), we sampled lions that were older than eighteen months of age.

Lions are known to be territorial (Johnsingh and Chellam 1991, Joslin 1973, Chellam 1993). Prides are found to be composed of related females, their young and sub-adult male offspring. Adult males are usually found as coalitions of 2-3, solitary, in temporary association with prides or with single females in oestrus. This social organization precludes the assumption of random mixing of lions and independent sighting probabilities. We attempted to address this issue by sampling areas at random for intensive searches for lions (White and Garrot 1990). Lion distribution, in summer, was determined to a great extent by availability of water (Chellam 1993). We stratified Gir Protected area into three strata; i) eastern Gir, ii) western Gir and iii) central Gir. We mapped all perennial sources of water in Gir and randomly selected 2-3 water sources within each stratum as centres for intensive search. Eight to ten days were spent in each of these areas looking for lions, using pug-marks, kills, roars and fresh scats as clues. Mainly, fresh pug-marks were located early in the morning, the tracks followed and lions located. Lions were then approached to within 20-40 m on foot and the whisker patterns determined. To increase sample size of individually identifiable lions, we opportunistically sampled any lion that we encountered within the study area.

The second sampling (n2) was more intensive and covered a short interval of eighteen days. It coincided with the Gujarat Forest Departments *total count* using baits. During this sample we spent approximately equal time and effort in western, central and eastern Gir. We also used a live goat to lure lions into becoming stationary till we had completed identifying their vibrissae patterns. The majority of our samples were obtained from lions on bait. A wireless radio network in Gir was our source of information for lions that were located during the *total count* exercise and we rushed to as many locations as possible with two vehicles that worked independently.

Sample Size Determination

It was important to estimate the minimum number of lions that should be sampled for achieving a desired precision for a population estimate. We performed computer simulations by varying the sample size for the first session (n1) between 20 and 80 lions and the sample size for the second session (n2) between 30 and 80. The simulation was run 500 times for each combination of nl and n2 for a hypothetical population of 250 lions. Recaptures were determined and population size (N) computed by equation 2.

Since we were also interested in the general application of sight-resight model to other large carnivore population we ran another simulation where the total population size was 50, 100 and 250 individuals. Most wildlife preserves in India are likely to have populations of tigers and leopards *(Pantherapardus)* ranging between the population sizes that we used for the simulations. For these simulations we sampled 25 and 50% (n1 + n2 = 25% and 50%, with n1 = n2) of the entire population. Coefficient of variation for the population estimates were computed and used as an index of precision.

Other Analyses

We performed 1000 modified jack-knife estimates (Krebs 1989) by randomly dropping 2 to 9 lions from nl and n2, determining m and computing N for each run. We plotted the N estimates and their standard deviations obtained from the simulation to ascertain the effect of reducing sample size on parameter estimate.

Results

Total Counts

It was not possible to estimate the precision of the *total counts*. The counts were likely to report minimum numbers. The technique was extremely labour intensive and expensive. It may become increasingly difficult in the future to use live bait due to animal rights awareness amongst the public. Since the same method for obtaining *total counts* has been employed since 1968, it would be possible to use the *total counts* for the past years as an index for Gir lion population trends (Fig. 2).

The lion population in Gir was increasing with an r = 0.022 ($\lambda = e^r = 1.0224$) for the past 25 years ($p = 0.0006$, $R^2 = 0.96$). There was a tendency towards achieving an asymptote by the population in 1995. However, the next *total count* will show whether the Gir lion population has stabilized or continues to increase.

Precision and Time-frame of Population Estimates

Population estimates with a 20% CV were unable to detect any change in the modelled declining lion population (95% CI) after 5 years, or even when the lion population was reduced to half its size (Fig. 3). A ten percent annual decline for a large carnivore is a serious cause for concern. In case of highly endangered species like the Asiatic lion, estimates need to be more precise so as to detect small changes in a

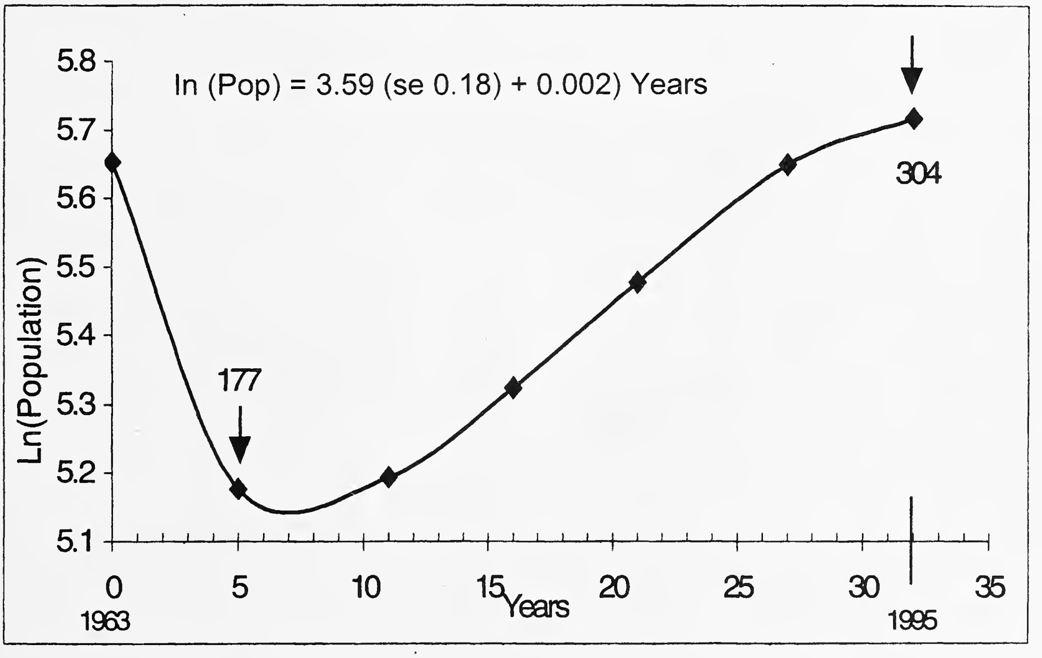

Fig. 2: Trends in the lion *total counts* in Gir between 1963 to 1995. The inset reports regression results for log transformed *total counts* between 1968 and 1995.

population. The current time frame of five years interval between total counts (the only form of population monitoring currently employed in Gir) is too long an interval for monitoring a highly endangered carnivore population.

Individual Identification of Lions

The maximum number of spots observed in row A for any lion were four. The whisker patterns of right and left side differed in the total number of spots (Table 1). We therefore used the left and right sides independently for calculating frequencies and probability of spots occurring in each position (Table 2).

The probability of finding any specific spot pattern on any one side of a lion would be the total product of probabilities of occurrence of each spot in row A (p_i) observed on that lion and the probabilities of spots not occurring (q_i) in the remaining potential spot positions. Thus the probability of a lion having 2 spots in row A on the left side at locations 3 and 5 would be:

TABLE 1
FREQUENCY OF DIFFERENT NUMBER OF VIBRISSAE SPOTS OBSERVED IN ROW 'A' ON LEFT AND RIGHT SIDES FROM A SAMPLE OF 74 LIONS.

No. of Spots in Row A	Left Side	Right Side
0	1	10
1	43	35
2	22	21
3	6	7
4	2	1

χ^2 between left and right sides = 8.62, $p < 0.05$.

P (left) = p3 x p5 x q1 x q2 x q4 x q6 x q7 x q8 x q9 x q10 x q11 x q12 x q13 x q14 x q15 x q16...........equation 4

Values for p_i and q_i were computed from a sample of 74 lions (nl number of wild lions and captive Asiatic lions) (Table 2).

The frequency of left and right sides having a particular number of spots in the sample population of 74 lions was compared with the aggregate probability of all combinations having that number, as calculated from equation 4 and Table 2 (Table 3). We observed that two spots occurred more often than expected on both sides

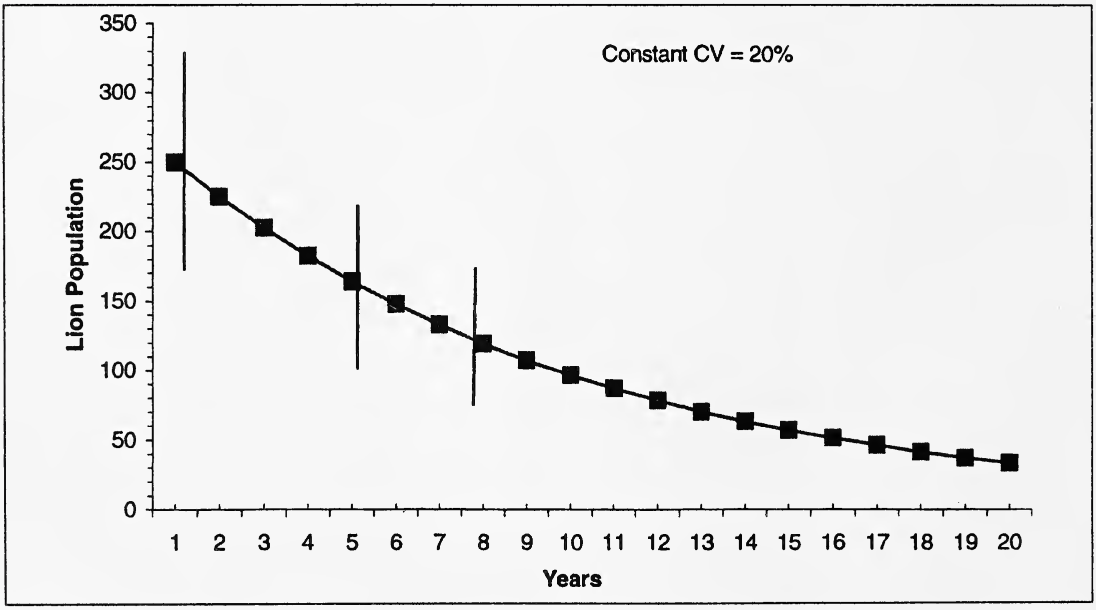

Fig. 3: A modeled population of 250 lions declining at the rate of ten percent per year. The vertical lines are 95% confidence intervals on population estimates (using CV=20%).

TABLE 2
FREQUENCY (Frq.) AND PROBABILITY (p) OF OCCURRENCE OF SPOTS AND PROBABILITY (q) OF SPOTS NOT OCCURRING AT EACH POSITION ON THE LEFT (Lt) AND RIGHT (Rt) SIDE IN ROW A. (COMPUTED FROM A SAMPLE OF 74 ASIATIC LIONS)

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Lt. Frq.	0	0	5	6	15	20	11	9	10	7	6	10	11	3	0	0
Lt. Prob. p	0	0	0.068	0.018	0.202	0.27	0.149	0.122	0.135	0.095	0.081	0.135	0.149	0.041	0	0
Lt. 1-p=q	1	1	0.932	0.919	0.798	0.73	0.851	0.878	0.865	0.905	0.919	0.865	0.851	0.959	1	1
Rt. Frq.	1	0	5	3	12	16	11	12	3	13	7	10	7	1	0	1
Rt. Prob. p	0.014	0	0.068	0.041	0.162	0.216	0.149	0.162	0.041	0.176	0.095	0.135	0.095	0.014	0	0.014
Rt. 1-p=q	0.986	1	0.932	0.959	0.838	0.784	0.851	0.838	0.959	0.824	0.905	0.865	0.905	0.986	1	0.986

and that one spot occurred more often than expected on the left side of our sample lions (Table 3). The occurrence of no spots on the left side was lower than expected in our sample. This lack of independence of spot patterns would reduce the level of reliability of individual identification of lions.

The probability that more than one lion has a particular pattern in a population of 300 lions is given by:

$$\Pi_x = p^x \cdot (1-p)^{M-x} \cdot M! / X!(M-x)!$$
$$\Pi_0 + \Pi_1 = (1-p)^M + Mp\,(1-p)^{M-1} > 1 - \varepsilon$$

Π_x = Probability that x individuals have a particular pattern; ε = Error term
p = Probability of pattern occurrence
x = Number of individual with particular pattern
M = Total population (300)
INFORMATION CONTENT
$I = -\log_2 p$
I = Information content in bits

To match the reliability criteria we would expect this probability to be $\varepsilon < 0.05$ i.e. there would be less than five percent chance of another lion having the same identifying characteristics in a population of 300 lions. Considering the information from row A alone, all but one lion met the stringent criteria of reliable identification. We combined information of row A patterns with information on the number of spots in row B and the sex of the lion. With this combination of information the possibility of confusing 2 lions in a population of 300 lions was, on an average, one in ten thousand (Fig. 4).

In accordance with the information theory (Pennycuick and Rudnai 1970), for a lion to be identified definitively from amongst a population of 300 lions, the individual must convey a minimum of nine bits of information. All sampled lions met this criterion and most had over 15 bits of information (Fig. 5).

TABLE 3
OBSERVED AND EXPECTED NUMBER OF VIBRISSAE SPOTS ON LEFT AND RIGHT SIDES OF 74 LIONS WITH DIFFERENT NUMBERS OF SPOTS

No. Spots	No. Possible Combinations	Aggregate Prob. Left Side	Expected Left Side	Actual No. Left Side	Chi Square Contribution	Aggregate Prob. Right Side	Expected Right Side	Actual No. Right Side	Chi Square Contri-bution
0	1	0.1 893	14	1	12.07	0.228	16.872	10	2.79
1	14	0.3448	25	43	12.96	0.336	27.084	35	2.30
2	91	0.1289	9.54	22	16.27	0.031	2.294	21	152.03
3	364	0.1336	9.89	6	1.53	0.109	8.066	7	0.14
4	1001	0.042	3.106	2	0.39	0.03	2.22	1	0.67
Total					43.22				157.95

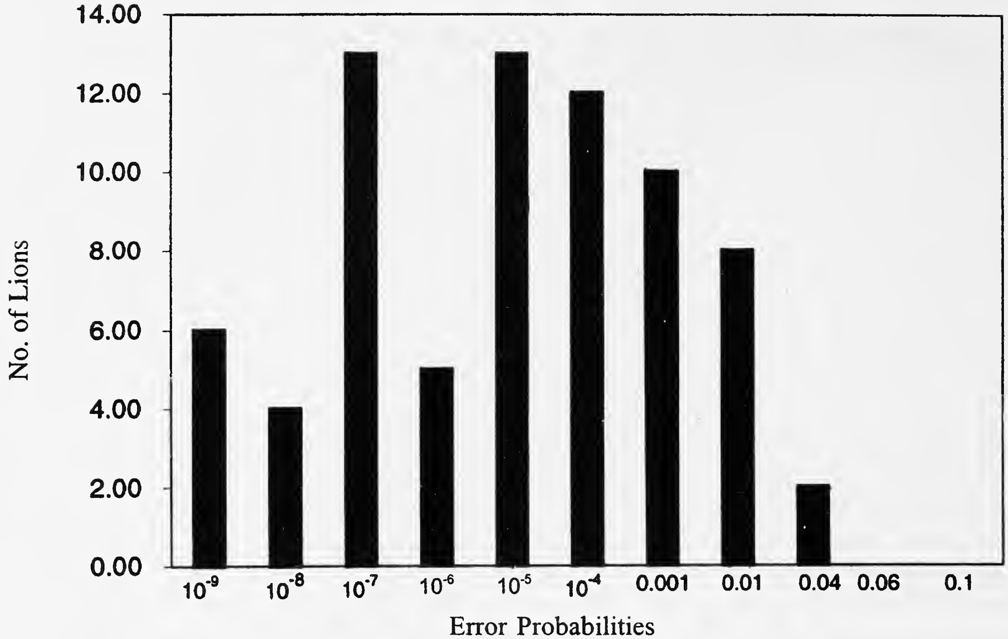

Fig. 4: The distribution of sampled lions with the various probabilities of reliable identification in a population of 300 lions after considering information in spot patterns in row A, number of spots in row B and the sex of the lion.

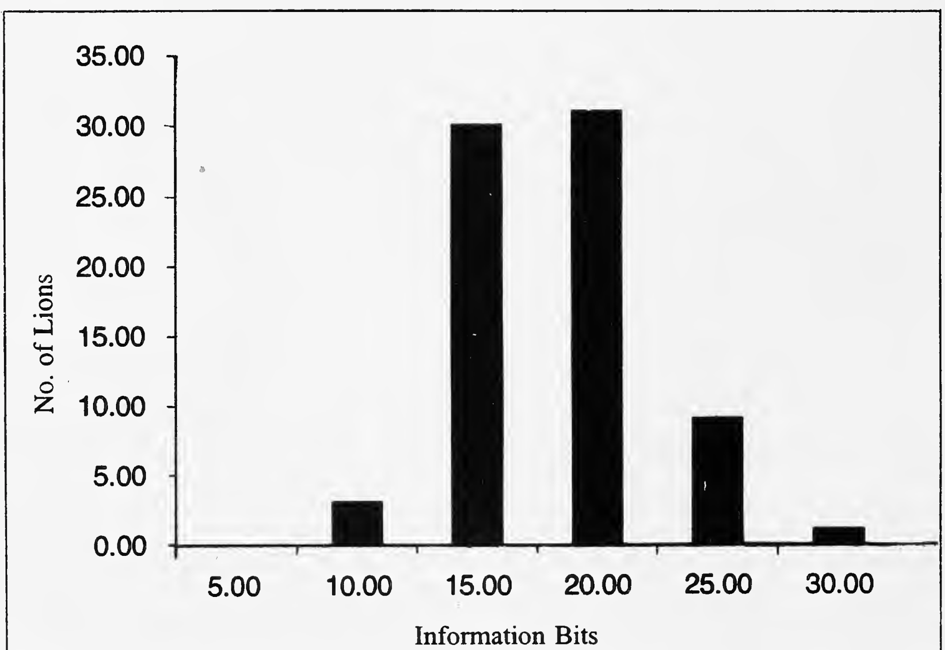

Fig. 5: Information bits from row A spot pattern, number of spots in row B, and sex of the sampled lions.

Sample Size Estimation

Our simulation results showed that to obtain a meaningful estimate of population size we needed to sample over 80 lions from a hypothetical population of 250. The results of the simulation were less sensitive to different magnitudes of nl and n2 as long as the sum of nl and n2 remained constant. The greater the magnitude of nl+n2, the higher was the precision of the estimate. For a given sum of nl and n2, minimum variation in parameter estimates was obtained when nl and n2 were of equal magnitude.

In the case of varying population sizes (50, 100, 250) where a constant proportion was sampled (constant sampling effort), the % CV was lower for larger populations than smaller populations for the same sampling effort. This suggests the need for more intensive sampling in smaller populations to obtain a similar level of precision in population estimates (Fig. 6).

Population Estimation

The number of lions sighted and identified for the first sample (n1) were 40. The second sample (n2) consisted of 48 lions. The number of recaptures m, exact matches, were 8 lions. We were uncertain regarding the resighting of one lioness due to a difference of a light spot seen during the second sampling. Considering the sex, location and pride composition of this lioness, it seems very likely that this was indeed a recapture and the spot was missed during nl session (marking). All computations were done considering m to be 8 as well as 9 (Table 4). A separate analysis of the male and female populations estimated 74 (sd 17) males and 167 (sd 67) females (using m=8).

The simulations using the modified jack-knife estimator provided an unbiased estimate of the lion number. However, precision decreased with decrease in nl and n2 (Fig. 7). This result also agreed with the results of our

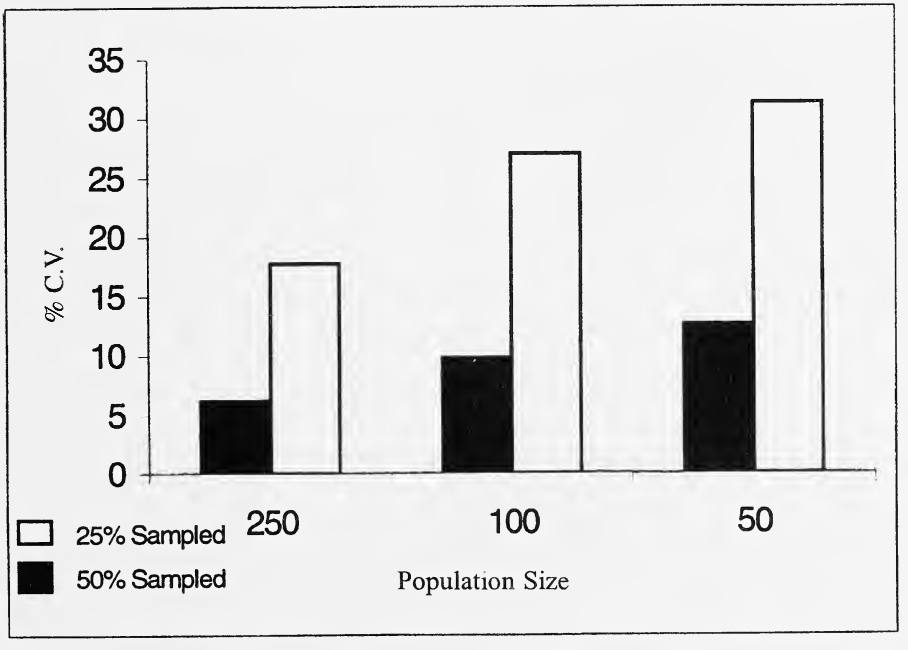

Fig. 6: Precision of population estimates (%CV) in relation to sampling effort (proportion of population sampled) and population size.

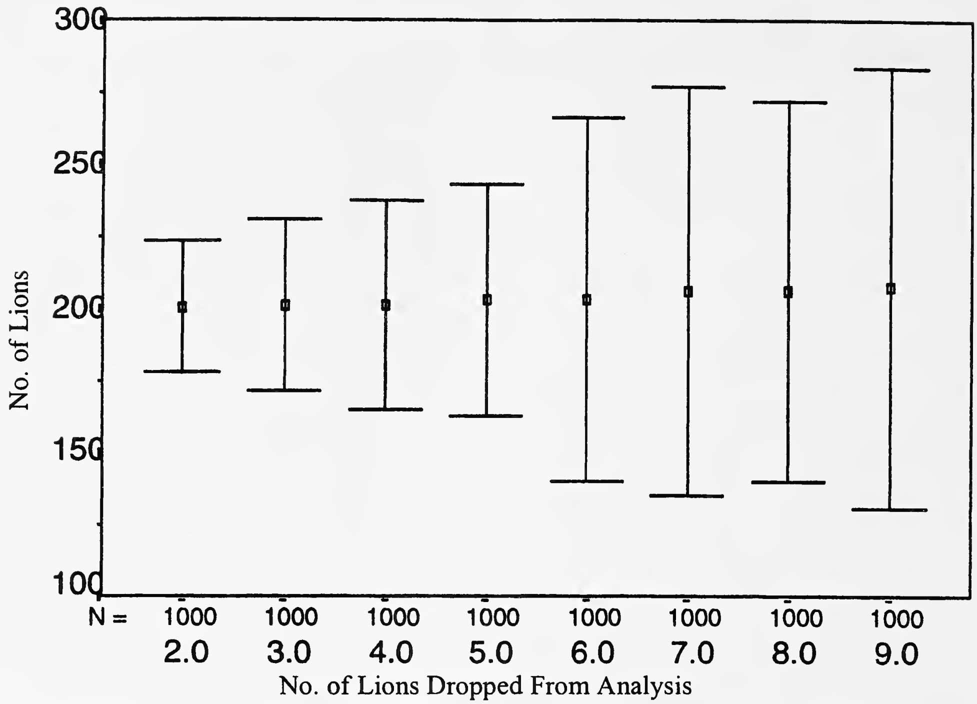

Fig. 7: Modified Jack-knife estimates of the lion population obtained by randomly dropping 2-9 lions from n1 and n2 and population size estimated for each run. The error bars are standard deviations obtained from 1000 simulation runs of each scenario.

TABLE 4
POPULATION ESTIMATES OF ADULT LIONS IN GIR FOREST, GUJARAT, 1995

Model	Population Estimate		Standard Deviation		% CV	
n1=40, n2=48	m=8	m=9	m=8	m=9	m=8	m=9
Lincon-Petersen	222	200	56	47	25	23.5
Modified Jack-Knife	224	201	37	23	16.7	11.4
Total Count	204					

simulations for estimating sample size (Fig. 6). Both the models agreed with regard to population estimates that ranged between 201 to 224 lions (Table 4). The modified jack-knife estimates had a lower coefficient of variation (Table 4) in comparison to the Chapman (1951) estimator. All estimates included the Forest Department's *total count* of 204 lions as a point estimate within one standard deviation of the mean.

DISCUSSION

Total Counts

The data for the population estimates used for the analysis of population trend were obtained from literature and reports (Dalvi 1969, Joslin 1973, Chellam 1993, Singh 1997). The total count method inherently precludes any estimate of precision or accuracy of the population estimates. The tendency of reporting an increasing population in subsequent censuses, for political reasons, may have been a source of bias in the reported total counts. We can only speculate that since the method used for all the counts between 1968 and 1997 were the same, biases (if any) in the estimates would be similar, and therefore total counts would at best be a good index of the population trend of lions in the Gir Protected Area.

Several government and non-government organizations, reputed naturalists, and wildlife scientists were invited by the Forest Department

to participate in the total count exercise conducted in 1995. Since three of the senior authors participated in this exercise, we are in a position to complement its sincerity and sheer magnitude of effort that was invested by the Department during the data collection phase. However, none of the invited agencies or individuals were involved in the analysis of the data on the total counts. Lack of transparency at this crucial stage was arguably the major drawback of the 1995 total count and probably also of earlier counts.

Assumptions of the Mark-Recapture Model

Computer simulation results for estimating mountain sheep *(Ovis canadensis)* numbers, with various degrees of aggregation by mark-resight estimates, have shown that violation of the independent sighting assumption results in lowered precision of estimates, while accuracy and confidence interval coverage were relatively unaffected by aggregation (Neal *et al.* 1993). The strategy of randomly searching pre-determined areas for lions would, to some extent, ensure equal probability of sighting different lions from the Gir population (White and Garrot 1990). We did observe heterogeneity of sighting probability between individual lions. The lions of western Gir were more conducive to permitting close approach for individual identification, while those of eastern Gir were relatively skittish and more aggressive. This behaviour was likely due to the western Gir lion population being habituated by exposure to tourism. During the entire study, we came across four lions that did not permit us to ascertain their individual identity. One lioness we tracked early morning kept moving, and after following her for 2 km on foot we lost her. The other three were males that were extremely aggressive and did not permit us to approach sufficiently close on foot to ascertain their identification. Heterogeneity of sighting probabilities produces a negative bias on population estimates (Neal *et al.* 1993, Seber 1982).

Even though our analysis suggests non-independence of spot patterns (Table 3), we believe that the combination of spot patterns, unique markings, age and sex information of Gir lions were adequate to uniquely identify each lion in the gir population. Rudnai and Pennicuick (1970) have shown that the vibrissae spots do not change at least over the period of 19 months. In the case of Asian lions, vibrissae spots did not change for the captive lion population in the Safari Park in Gir and Sakkarbag Zoo at Junagadh over the span of one year. Tthus, the vibrissae spot patterns could be considered to be permanent at least over the period of the current sampling (one year).

We were uncertain regarding the resighting of one lion due to a difference of a light spot seen during the second sampling. This suggests that even though the vibrissae pattern along with other natural markings was found to have sufficient information for unique individual identification of lions in Gir, there existed a possibility of observer errors in quantification of vibrissae patterns. Errors in identification would also affect the population estimates.

Population Estimates

The highest precision was obtained by the modified jack-knife estimate which had the lowest standard deviation. However, the CV was still over 10% (CV = 11.4 to 16%) and would not therefore meet the rigorous criteria of detecting a 10% decline between years (Fig. 3) (Taylor and Gerrodette 1993). The lower value of the 95% confidence interval on the smallest population estimate (Lincoln-Peterson with m = 9, Table 4) was 108 lions, while the upper value of the 95% confidence interval on the largest population estimate (modified jack-knife, m = 8) was 297 lions. We believe that the adult lion population in Gir protected area was between 108 and 297 in 1995 with 95% certainty.

This study exemplifies the need for large samples for precise estimates using

mark-recapture models. Sampling effort would need to be disproportionally larger for smaller populations (Fig. 6). Lions are relatively easy to sample and "mark" and such large samples could be made a reality. However, the practical use of these models for estimating tiger and leopards remains questionable.

There would be a gain in population estimate precision if the Jolly-Seber model (Pollock *et al.* 1990) or its modified versions, which include several continuous marking and capture sessions, were used (Anderson and Burnham 1994, Bowden and Kufeld 1995, Neal *et al.* 1993). Combination of mark-recapture models with other methods like radiotelemetry would go a long way in improving population estimates of large carnivores (Neal *et al.* 1993). Such models and combination of techniques would also enable the study of survival, mortality, and dispersion, in addition to estimating population size or density.

For a highly endangered large carnivore like the Asiatic lion, a continuous scheme for monitoring the lion population needs to be implemented. The estimation of the total numbers of lions may be inconsequential for detecting trends in the lion population (Eberhardt and Knight 1996, Karanth 1987, Karanth and Nicholes in press). Our simulation study suggests that the best current techniques used for estimating large carnivore numbers are likely to lack statistical power for detecting trends among populations. The monitoring scheme could be based on population indices and should have the statistical power of detecting slight changes in lion populations (Taylor and Gerrodette 1993). The monitoring program would enable timely management inputs in the form of rectifying measures for control of poaching, disease and other sources of mortality. Our study suggests the possibility of utilising the vibrissae pattern in comination with other information for reasonably accurate individual identification and monitoring of the Gir lion population on an annual basis. This technique of identification, coupled with more refined statistical models with multiple marking and capture sessions, would improve population estimates and provide additional information on the demography of Gir lions (Leberton *et al.* 1992).

Acknowledgements

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CONSERVATION STATUS AND DISTRIBUTION OF SWAMP FRANCOLIN IN INDIA[1]

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(*With three text-figures*)

Key words: Swamp francolin, *Francolinus gularis*, conservation, *terai*, grasslands, management

The swamp francolin *Francolinus gularis* is distributed in the tall wet grasslands along the Himalayan foothills. Of the 23 localities surveyed in 1988 and 1991 covering the entire *terai* and Brahmaputra flood plains in India, swamp francolin (SF) was confirmed from 12 sites; seven from Uttar Pradesh, one from Bihar and four from Assam. The swamp francolin shows significant preference ($P<0.001$) for different grass associations. *Sclerostachya fusca* and *Saccharum* spp. association is most preferred ($f = 0.82$). Distribution of swamp francolin is affected by the availability of water bodies ($P<0.005$). Swamp francolin sighting is inversely related with linear distance of a waterbody. Livestock grazing is negatively correlated with swamp francolin presence ($P<0.001$). Group size varies from 1-10 and most adults are found in pairs. Bigger flocks constitute parents and chicks. To improve the swamp francolin habitat, plantations in the grassland should be stopped and prescribed burning should be done in January or first half of February.

INTRODUCTION

The swamp francolin *Francolinus gularis*, distributed along the Himalayan foothills in tall, wet grasslands of the *terai* and the Brahmaputra flood plains, is endemic to the Indian subcontinent (Ali and Ripley 1987). It occurs in a few areas in Nepal (Inskipp and Inskipp 1991) but has probably completely disappeared in Bangladesh, as Harvey (1990) had no sighting, but felt that it might still occur in small numbers. Ali and Ripley (1987) described its exceptional occurrence in the Cherrapunji plateau (1200 m above msl).

Very little work has been done on the status and biology of the swamp francolin, except for brief surveys by Kaul and Kalsi (1990) and Javed and Rahmani (1991). A study was also conducted in Dudwa National Park to develop a suitable survey technique for swamp francolin census (McGowan *et al.* 1995). Based on these preliminary studies, a more detailed study on the habitat use of swamp francolin was conducted just outside Dudwa National Park (Iqubal *et al.* 1995). A preliminary study on the diet and activity pattern of swamp francolin was conducted in Nepal (Shreshta 1992).

The swamp francolin is a threatened species (Collar *et al.* 1994) and is considered vulnerable to extinction under the Mace-Lande (1991) threat criteria, because of the threat to its tall grass habitat. Widespread reclamation, and poaching, to some extent, have adversely affected swamp francolin distribution.

The aim of our study was to find out the factors affecting distribution patterns of swamp francolin and to evaluate the present conservation problems in protected and unprotected areas.

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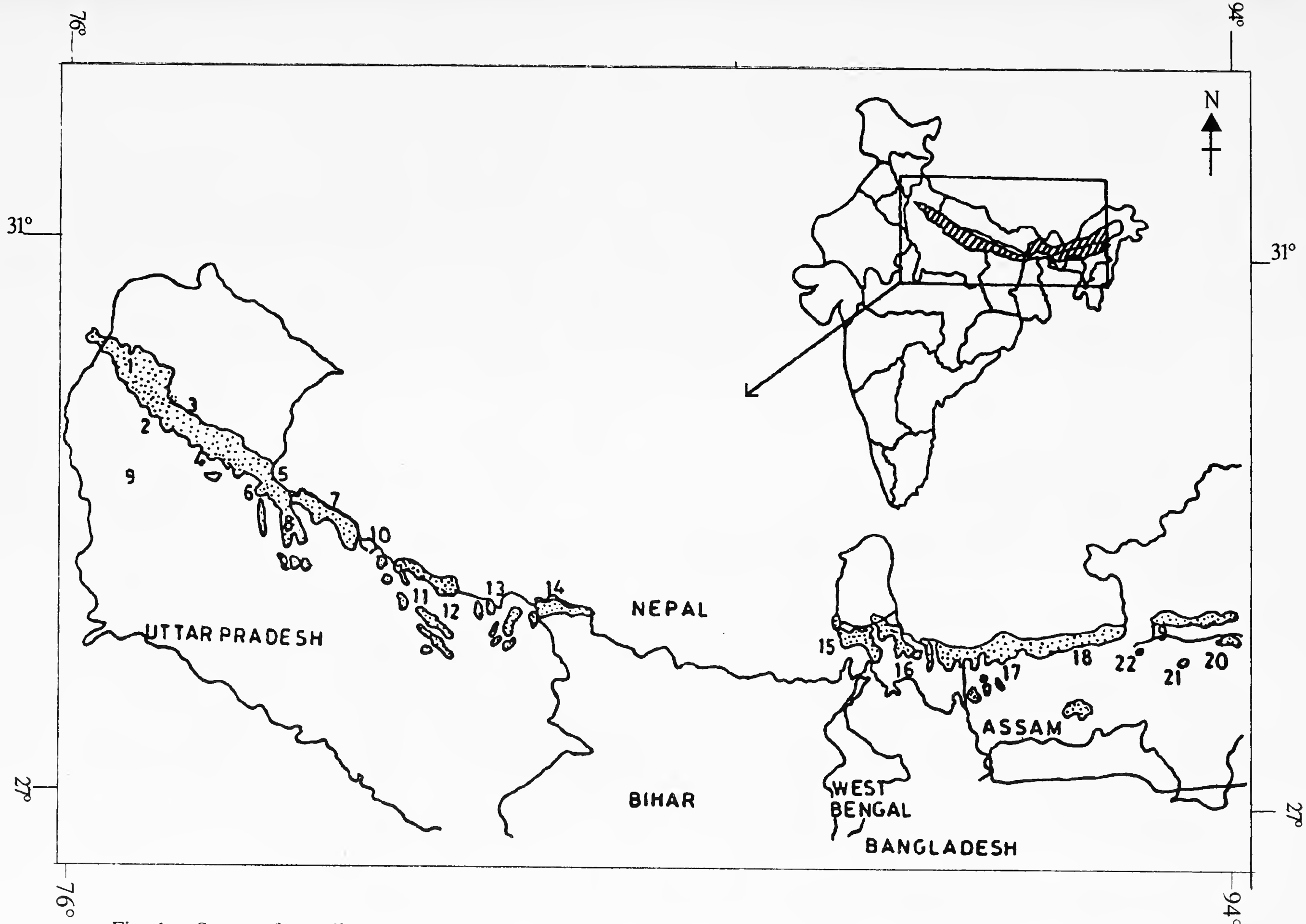

Fig. 1: Swamp francolin survey sites in India. 1. Rajaji National Park, 2. Lansdowne, 3. Hastinapur Sanctuary, 4. Corbett National Park, 5. Haldwani Division, 6. N. Pilibhit Division, 7. Lagga-bagga Reserve Forest, 8. Dudwa National Park, 9. Kishanpur Sanctuary, 10. Katarnia-ghat Sanctuary, 11. Suhelwa Sanctuary, 12. Sohagi Barua Sanctuary, 13. N. Gorakhpur Division, 14. Valmikinagar Tiger Reserve, 15. Jaldapara Sanctuary, 16. Manas Tiger Reserve, 17. Bornadi Sanctuary, 18. Sonai Rupai Sanctuary, 19. Kaziranga National Park, 20. Laokhowa Sanctuary, 21. Orang Sanctuary, 22. Pobitara Sanctuary (see Table 2)

Study Area

TERAI

Terai region is a flat stretch of alluvial land between the Himalayan foothills and the Gangetic plain. It extends through Uttar Pradesh, parts of Bihar, northwest Bengal, Assam and Nepal. It is characterised by soil which is clayey, boulderless and with high moisture content. The high water table and annual precipitation from 1000 to 1800 mm per annum play an important role in determining the characteristic vegetation of the whole region. The vegetation is of the moist deciduous type, dominated by extensive patches of sal *Shorea robusta* forest, interspersed with grasslands dominated by *Saccharum, Typha, Narenga* and *Sclerostachya* species.

Till the early 1950's the whole *terai* region was very thinly populated except for the tribal *tharus* who inhabited the area. The north Indian *terai*, which once covered 12 districts of Uttar Pradesh, is now restricted to the districts of Pilibhit, Lakhimpur-Kheri, Bahraich, Gonda and Gorakhpur, covering an area of about 6500 sq. km. The uncontrolled expansion of agriculture, current land-use pattern and other biotic and abiotic factors have reduced the once extensive *terai* into small fragments (Fig. 1). As a result, what exists today is in protected areas such as national parks and sanctuaries amidst a sea of cropland and human settlements under high biotic pressure.

DUDWA NATIONAL PARK

Dudwa National Park is situated on the Indo-Nepal border in Nigahasan tehsil of Lakhimpur-Kheri dist., Uttar Pradesh. The area falls under the Terai-Bhabar biogeographic subdivision of the Upper Gangetic Plain (7A) according to the classification of Rodgers and Panwar (1988). The Park lies between 28° 18' and 28° 42' N lat., and between 80° 28' and 80° 27' E long. The Himalayan foothills lie about 30 km to the north of the Park. The Suheli river on the southern side and the Mohana river on the north form the natural boundaries of the Park. The topography is flat, with a maximum elevation of 182 m above msl. To protect the relict population of swamp deer *Cervus duvauceli* in particular, an area of 212 km^2 was declared as a Sanctuary. In 1977, the area was declared as a National Park with a core zone of 490 sq. km and a buffer zone of 124 km^2. The buffer zone in Dudwa National Park (DNP) is located to the north of the core zone and includes *tharu* tribal villages. About 30,000 people continue to live in a stretch of land approximately 5 km wide in and around the Park (Singh 1982). They are partly dependent on the forest for thatching, fodder and fuel wood, thus creating an important management issue (Javed 1996).

Methods

Surveys were conducted in Uttar Pradesh, Bihar, West Bengal and Assam in 1988, while in 1991 only the former two states were surveyed. We surveyed all the protected forests and sizable patches (3-5 sq. km) of conservation importance in the entire north Indian *terai* belt and the Brahmaputra flood plains.

Data on habitat preference and factors affecting the distribution of swamp francolin were collected from 1988 to 1994 in Dudwa National Park. On the basis of reconnaissance surveys, a few locations were selected for random transects. Casual sightings of swamp francolin were also included. Variables recorded for each francolin observed were vegetation associations, phenophase, cover value, distance of water source (linear distance), disturbance factors such as cattle grazing, grass cutting, plantation (year of plantation, extent and success of plantation), fire, draining of wetlands and encroachment. Vehicular census was done along motorable paths. At intensive study sites i.e. Sathiana (40 sq. km) and Kakraha (24.5 sq. km) in Dudwa, permanent transects of varying length from 1 to 2 km were laid in different vegetation types. Parameters recorded were the same as discussed in the survey methods, except that in the intensive

study areas the effects of fire and flood were also studied. To record the effect of burning, animals flushed from burning sites and areas utilized at the time of burning were noted. During floods, observations were made from elephant back in different grassland types.

ANALYSES

Actual sightings and calls were considered for analysis. Each call heard was considered as a sighting record. Care was taken to avoid duplication of calls/sighting. Dudwa grasslands are divided into four broad categories (Qureshi *et al.* 1990), (a) Tall wet grassland, (b) Short grassland (c) Moist savanna and (d) Derived grassland due to anthropogenic factors (Table 1). Ten associations were identified in these categories (Qureshi *et al.* 1990). To calculate habitat preference, we clumped the associations into three groups, depending on the dominant grass species. Group I - *Phragmites karka, Arundo donax, Sclerostachya fusca, Saccharum* spp. (except *S. munja*), *Themeda arundinacea* and *Narenga porphyrocoma*. Group II - *Imperata cylindrica, Vetiveria zizanoides, Desmostachya bipinnata* and *Eulaliopsis binata*. Group III - *Saccharum munja, Cymbopogon martini* and *Imperata cylindrica* (drier type).

Chi-square test (with correction for continuity), Null hypothesis tested by the Chi-square test (Alleredge and Ratti 1986) based on data on availability and utilization of habitat, Kolmogrov-Smirov goodness of fit test. Fisher exact test, and Phi (Cramer's) coefficient (Zar 1984) were used for testing the significance of swamp francolin association with different grass associations, effect of cattle grazing and distance of francolins from water source.

TABLE 1

FREQUENCY OF DIFFERENT HABITAT TYPES IN INTENSIVE STUDY AREA (SATHIANA AND KAKRAHA) IN DUDWA NATIONAL PARK

Habitat Type	Percentage frequency occurrence of habits	Percentage area in the park (490 sq. km.)
Sal woodland	10	54.09
Moist Mixed Forest	7	6.85
Riparian Forest	5	5.99
Tall Wet Grassland	25	18.41
Derived Grassland	20	-
Moist Savanna	18	3.44
Wetland	5	2.98
Woodland grassland edge	10	-
Other woodland areas including plantation		8.83

TABLE 2

SWAMP FRANCOLIN SURVEY SITES

Locations	Area (sq. km.)	Swamp francolin records	Disturbance Lclvel
Uttar Pradesh			
Rajaji National Park	824	-	2
Lansdowne	604	-	3
Hastinapur Sanctuary	1280	-	3
Corbett National Park	384	-	0
Haldwani Division	1140	?	2
N. Pilibhit Division	550	+	2
Lagga-bagga Reserve Forest	11	+	3
Dudwa National Park	614	+	0
Kishanpur Sanctuary	277	+	1
Katarnia-ghat Sanctuary	400	+	2
Suhelwa Sanctuary	450	-	2
Sohagi Barua Sanctuary	428	+	2
N. Gorakhpur Division	-	+	2
Bihar			
Valmikinagar Tiger Reserve	462	+	2
West Bengal			
Jaldapara Sanctuary	118	?	2
Assam			
Manas Tiger Reserve	391	+	1
Bornadi Sanctuary	26	?	2
Sonai Rupai Sanctuary	175	?	3
Kaziranga National Park	430	+	1
Laokhowa Sanctuary	70	+	3
Orang Sanctuary	75	+	2
Pobitara Sanctuary	16	+	2

Disturbance level: 1 = Low, 2 = Medium, 3 = High

Results

Status Survey

Twenty-two localities were surveyed, and we found evidence of swamp francolin at 13 sites (Fig. 1, Table 2). With its presence in all well protected grasslands and its wide range of occurrence, this species seems to exist in far greater numbers than supposed earlier. The status of swamp francolin is comparatively good in Uttar Pradesh and Assam, while in Bihar it occurs only in Valmikinagar Tiger Reserve. Its presence in West Bengal is doubtful (Table 2). We did not see any swamp francolin during our visit to Jaldapara Sanctuary, although its presence is not unlikely there. Table 3 shows sighting of swamp francolin in and around Dudwa National Park between January 1991 and 1992.

Habitat use pattern

Broad habitat categories like tall, medium and short grasslands did not show significant correlation ($\chi^2 = 2.56$, $P>0.05$) with sightings of swamp francolin. Swamp francolin showed a

Table 3

SIGHTING OF SWAMP FRANCOLIN IN AND AROUND DUDWA NATIONAL PARK (JANUARY TO JUNE 1993)

	Locality	Adult	Chicks	Call
1.	Kakraha	2	5	+
2.	Chedia Taal	2	8	+
3.	Amaha	2	-	+
4.	Kurmania	2	-	+
5.	Base Camp	2	-	-
6.	Satiana FRH	1	3	+
7.	Partridge Cottage	-	-	+
8.	Chapra	2	6	+
9.	Kowwhaghati Bridge	-	-	+
10.	Makhan-bhouji	2	-	+
11.	Madriya	2,2,2	-	+
12.	Gajraula	2	3	+
13.	Qila	2	-	+
14.	Bhadi Taal	-	-	+
15	Atarnagar	1	2	-
16.	Ainthpur	1	-	-

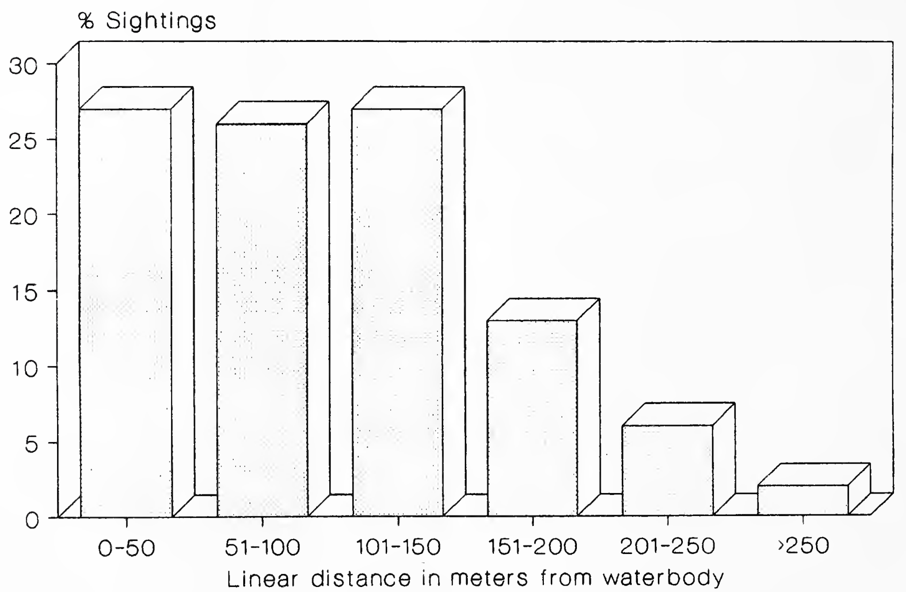

Fig. 2: Distribution of Swamp francolin at water bodies

significant preference for different associations of three groups of grass species (n = 50, dmax = 29.3, P<<0.001). The maximum association was with group I species (f = 0.82) of which *Sclerostachya fusca* and *Saccharum* spp. associations were utilized more. Group II species (f = -0.19) and group III species (f = 0.19) showed no correlation. The distribution of swamp francolin is further limited by distribution of water sources. Significant correlation (n = 48, dmax = 12, p<<0.005) was observed between swamp francolin sightings and linear distance of the water body. The majority of sightings occurred within 200 m of the water source (Fig. 2). Cattle grazing adversely affects swamp francolin; they withstand light grazing, but avoid medium to heavily grazed grassland patches (f = 0.90, P<<0.001, Fisher exact test). The sample size constrained to test the differential use of burnt and unburnt patches. At the time of burning, the swamp francolins took refuge in unburnt patches. Within a week after the burning, they were randomly distributed in burnt and unburnt patches. Burnt patches bordering unburnt grass patches were used more. During the peak flood period, swamp francolin take refuge in derived (highland) grassland occupied by group III species.

Group size

Swamp francolin group size varies from 1 to 10 (Fig. 3). The majority of sightings of adults (52%, n = 29) were in pairs. Four was the maximum group size in adults. Bigger groups constituted a pair with chicks. On an average, five chicks per pair or per mother (range of group size 2-8) were observed.

Discussion

Large-scale encroachment of grassland, plantation of commercially important trees such as *Eucalyptus, Dalbergia sissoo* and *Bombax ceiba*, and fragmentation of grassland are major threats to the future of swamp francolin. Table 2 indicates the level of anthropogenic disturbance in different areas. Swamp francolins are associated with tall wet grasslands (Ali and Ripley 1987). The group I species (*Phragmites, Arundo, Sclerostachya, Saccharum, Themeda* and *Narenga)* are distributed in seasonally inundated areas or near seasonal or perennial

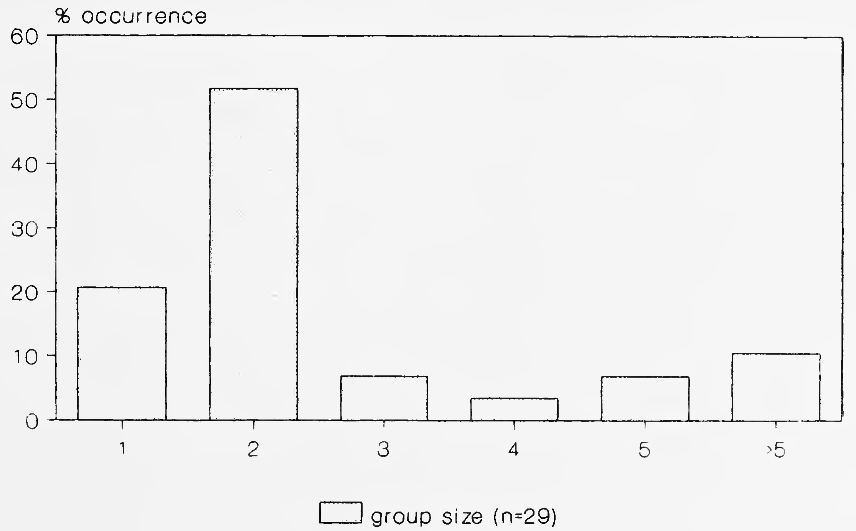

Fig. 3: Distribution of Swamp francolin in different group sizes

streams. Group I associations are preferred by swamp francolin for nesting, cover and for food. Seasonal trends of association use are not evident from our data. Nesting generally occurs on broken down grass stalks or near a waterbody on grass beds (Ali and Ripley 1987).

Cattle grazing has a negative effect on the use of an area by swamp francolin. Heavily grazed areas are avoided due to decrease in the density of the vegetation cover, while light grazing seems to have no effect. Species occupying habitat with dense vegetation cover are likely to be most sensitive to herbage removal (Sedgwick and Knopf 1987). Grazing pressure is generally high in summer, when post-burn nutritive grasses are available and water availability is limited.

The grasslands of the *terai* are burned from December to April in large areas varying from 1-5 sq. km. At the time of burning, the swamp francolin takes refuge in unburnt grass patches, generally near waterbodies or areas safe from fire. The nesting time of swamp francolin in the north Indian *terai* is during February-April. Thus it is suggested that grasslands should be burned in January and the first half of February, when burning will not have any adverse effect on nesting, and also provide sufficient cover. The mosaic of burnt and unburnt patches will provide sufficient feeding areas. It seems that sudden changes in grassland structure due to burning may have an effect on ranging pattern, but this needs further study. Within a week of burning, the birds were seen utilizing burnt patches. Rank grass patches not burnt for 2 to 3 or more years, forming thick tangles of dead and live material, are avoided by swamp francolins. Studies on grey-winged and red-winged francolins in South Africa indicate that burnt grass patches were preferred by these francolins (Mentis and Begalke 1979). It seems that fire did not have any negative effect on nesting success, as adequate nesting habitat was available in the form of unburnt patches. Sightings of chicks in all the years except 1990 support our view. The reason for the decline in chick survival rate is not understood, and the effect of fire on nesting success and chick survival needs further investigation.

Sightings of swamp francolin in agriculture dominated areas are centred around sugarcane (*Saccharum officinarum*) and paddy (*Oryza sativa*) interspersed with waterbodies (marshes) of various sizes having natural vegetation. All sightings in croplands occurred within 200 metres of marshes having associates of group I species. The croplands are also shared by the black (*F. francolinus*) and grey (*F. pondicerianus*) francolins.

In its entire range of distribution, large-scale conversion of grassland for agriculture and plantation render most of the area unsuitable for swamp francolins. Plantation in grassland should be stopped and encroachment on grassland in protected and unprotected areas should be checked. Cattle grazing should be minimized as per the local situation and grassland should be burned at the end of February or in the first half of February, leaving some patches unburnt, thus creating a mosaic of burnt and unburnt patches to facilitate nesting.

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SEASONAL FOOD PREFERENCE OF THE INDIAN SHORT NOSED FRUIT BAT *CYNOPTERUS SPHINX* (VAHL) (CHIROPTERA: PTEROPODIDAE)[1]

K. EMMANUVEL RAJAN, N. GOPUKUMAR NAIR AND R. SUBBARAJ[2]

Key words: *Cynopterus sphinx*, roosting tents, food items, folivory, food preference, foraging strategy

The short-nosed fruit bat *Cynopterus sphinx* occurs widely in India. These plant-visiting bats feed upon fruits, leaves and flowers. They also modify the leaves of certain plants as "tents" for roosting. Since the availability of fruits and flowers is seasonal, their food items vary over the seasons. In addition to feeding on fruits and flowers, these bats also feed on the leaves of *Cassia fistula* throughout the year. Such folivory of these bats may be energetically more advantageous to them than frugivory.

INTRODUCTION

A number of neotropical and palaeotropical bats are known to modify leaves of plants as "tents" for use as daytime roosts (Barbour 1932). The Indian short-nosed fruit bat *Cynopterus sphinx* roosts in modified leaves of the creeper *Vernonia scandens* and mast tree *Polyalthia longifolia* (Balasingh *et al.* 1993). Plant-visiting bats from both the neotropics and palaeotropics are known to feed on different plant parts such as flowers, pollen, fruit, nectar and leaves (Kunz and Diaz 1995). In all, 250 species of bats representing two families (Phyllostomidae and Pteropodidae) depend on plants as a source of food (Fleming 1988). McCann (1940) observed *C. sphinx* feeding on ripe dates. He concluded that these bats drank the juice and discarded the pulp.

The available information relating to the food habits of *C. sphinx* was mainly based on casual or incidental observations which have been reviewed and summarized. Considering the paucity of information on food habits of *C. sphinx* in southern India, the present study was

TABLE 1
FOOD PLANTS OF *CYNOPTERUS SPHINX*

Family	Species	Food type
Annonaceae	*Polyalthia longifolia* Thw.	Fruit
	Annona squamosa Linn.	Fruit
Moraceae	*Ficus bengalensis* Linn.	Fruit
	Ficus religiosa Linn.	Fruit
	Morus alba Linn.	Fruit
Mimosaceae	*Enterolobium saman*	Fruit
	Pithecellobium dulce Benth.	Fruit
	Acacia nilotica Linn.	Fruit
Sapotaceae	*Achras zapota* Linn.	Fruit
	Bassia latifolia Roxb.	Fruit & Flowers
	Mimusops elengi Linn.	Fruit
Myrtaceae	*Psidium guajava* Linn.	Fruit
	Eugenia jambolana Lam.	Fruit
Combretaceae	*Terminalia catappa* Linn.	Fruit
Caesalpiniaceae	*Cassia fistula* Linn.	Leaves
Anacardiaceae	*Mangifera indica* Linn.	Fruit & Flowers
Rutaceae	*Murraya koenigii* Sperg.	Fruit
Clusiaceae	*Calophyllum inophyllum* Linn.	Fruit
Punicaceae	*Punica granatum* Linn.	Fruit
Meliaceae	*Azadirachta indica* A. Juss.	Fruit
Cucurbitaceae	*Cephalandra indica* Naud.	Fruit
Solanaceae	*Solanum torvum* Sw.	Fruit
Rhamnaceae	*Ziziphus jujuba* Mill.	Fruit

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TABLE 2
FEEDING SEASONALITY OF *C. SPHINX* ON DIFFERENT SPECIES OF PLANTS

Species	Parts eaten	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Polyalthia longifolia	Fruit	+	+	-	-	-	-	-	+	+	+	+	+
Annona squamosa	Fruit	-	-	-	-	-	+	-	-	-	-	+	-
Ficus bengalensis	Fruit	+	+	-	-	+	-	+	+	-	-	-	-
Ficus religiosa	Fruit	-	-	+	+	+	-	-	+	+	-	-	+
Morus alba	Fruit	-	-	-	-	+	+	-	-	-	+	+	-
Enterolobium saman	Fruit	-	-	-	-	+	+	-	-	-	-	-	-
Pithecellobium dulce	Fruit	-	-	-	-	+	+	+	-	-	-	-	-
Acacia nilotica	Fruit	-	-	-	-	-	-	-	-	+	+	-	-
Achras zapota	Fruit	+	+	-	+	-	-	-	-	-	-	-	-
Bassia latifolia	Flowers	-	-	-	-	+	-	-	-	-	-	-	-
Bassia latifolia	Fruit	-	-	-	-	-	-	-	+	+	+	-	-
Mimusops elengi	Fruit	-	-	-	+	+	+	+	-	-	-	-	-
Psidium guajava	Fruit	-	-	-	+	+	+	-	-	-	-	-	-
Eugenia jambolana	Fruit	-	-	-	-	-	-	-	-	+	-	-	-
Terminalia catappa	Fruit	-	+	+	+	+	+	+	+	-	-	-	-
Cassia fistula	Leaves	+	+	+	+	+	+	+	+	+	+	+	+
Mangifera indica	Flowers	-	-	-	+	+	-	-	-	-	-	-	-
Mangifera indica	Fruit	-	-	-	-	-	+	+	-	-	-	-	-
Murraya koenigii	Fruit	-	-	-	-	-	-	-	-	-	+	-	-
Calophyllum inophyllum	Fruit	-	-	-	+	+	+	+	-	-	-	-	-
Punica granatum	Fruit	-	-	-	-	-	-	-	-	+	+	-	-
Azadirachta indica	Fruit	-	-	-	-	-	-	-	+	+	+	-	-
Cephalandra indica	Fruit	+	-	-	+	+	-	+	-	-	+	-	+
Solanum torvum	Fruit	+	-	-	-	-	+	-	-	-	-	-	-
Ziziphus jujuba	Fruit	-	-	-	+	+	-	-	-	-	-	-	-
Vitis vinifera	Fruit	-	-	-	-	-	-	+	-	-	-	-	-
Lannea coromandelica	Fruit	-	-	-	-	-	-	+	-	-	-	-	-

+: Presence of fruits/flowers/leaves.

undertaken to determine the seasonal food preference and feeding behaviour of *C. sphinx.*

Study Area and Methods

Studies were carried out (November 95-October 96) around the campus of the Madurai Kamaraj University (9° 58' N lat.; 78° 10' E long.).

Seeds and a large number of partially chewed fragments of plant parts were dropped by *C. sphinx* beneath the feeding roost and day roost "tents". The plants ingested were identified by the seeds, fibre pellets, and leaves, which were collected under feeding roosts and "tents". These remnants were collected in the early morning hours on alternate days of our study period. In addition, observations were also made in different fruiting seasons, on the bats while they were feeding at the feeding perches, and in the "tents" during the night with the help of red filtered torch light (> 610 nm).

The flowering, fruiting and the availability of different food items during different months of the year were recorded.

Observations

Day roosts of *C. sphinx* (numbers varying from 2 to 11 individuals) were located by tracing the fecal pellets and remains of fruit, leaves and flowers. Six day roosts with a single bat or small groups were located under a funnel and boat shaped tents made out of dry fronds of palmyra palm, *Borassus flabellifer.* Most of these roosts are used for weeks or months, and as a "maternity home".

While returning from foraging, *C. sphinx* carry different parts of plants to the day roosting sites. If the fruits are too large to transport (e.g. *Annona squamosa*, *Mangifera indica*, *Psidium guajava*) they are consumed *in situ* on the fruiting trees. The food of *C. sphinx* is listed in Table 1. The seasonal availability of plant food on which the bats feed are listed in Table 2.

In the present study, *C. sphinx* was observed to feed on 25 plant species. This bat mostly prefer the fruit of *Terminalia catappa*, which is available for a longer duration over the season (7 months). Various species of pteropodid bats, including *Cynopterus,* have been reported to forage on the fruits of more than 30 species of plants in tropical and subtropical regions (Fujita 1991).

C. sphinx also feeds regularly on the leaves of *C. fistula.* This was also observed by Balasubramanian (1988) and Bhat (1994). Such folivory may be energetically more advantageous for the bats than the ingestion of abundant amounts of low-protein fruits (Kunz and Ingalls 1994). Marshall (1983) observed that *C. sphinx* feed on flowers of several plant species.

Bhat (1994) observed *C. sphinx* feeding only on the flowers of *Parkia biglandulosa,* and *Madhuca latifolia*. However, during the present study we observed that *C. sphinx* also feed on the flowers of *Bassia latifolia* and *Mangifera indica*. The foraging strategy of these bats, therefore, depends on the availability, apart from their preference, of different plant parts throughout the year.

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A PRELIMINARY GUIDE FOR AGE AND SEX DETERMINATION OF THE HOUBARA BUSTARD *CHLAMYDOTIS UNDULATA MACQUEENII*[1]

NIGEL S. JARRETT AND STEPHANIE M. WARREN[2]

(*With four text-figures and three plates*)

Key words: Age determination, sex determination houbara bustard, *Chlamydotis undulata macqueenii*

For 16 first year and 20 adult captive houbara bustard *Chlamydotis undulata macqueenii,* data were collected on the moult sequence and feather characteristics of wing and tail plumage. First year birds replaced most juvenile plumage with first adult plumage before age 6 months, but retained various inner secondaries, greater secondary coverts, outer primaries and corresponding coverts, and outer tail feathers for at least 10-11 months. A free-living houbara, caught in Kazakhstan in May, had retained juvenile outer primaries, primary coverts, inner secondaries and outer tail feathers. These data suggest that the presence of retained juvenile plumage may enable field workers handling free-living houbara to separate birds in their first calendar year from adults. The feather characteristics (shape, colour and pattern) of relevant juvenile and adult plumage are presented, and criteria for separating the two age classes are highlighted.

Morphometrics (head, culmen, tarsus, middle toe and sternum length) were taken for 129 adult birds of known sex. For each morphometric variable, males were significantly larger than females (between 9% and 15%). However, the range of each variable overlapped between the sexes. Discriminant analysis of morphometric data correctly classified the gender of 99% of individuals: 100% of females and 98.7% of males; one male was misclassified. The same result was achieved whether all five variables, or two variables only (head and tarsus), were used in the analysis. Equations to classify the gender of adult birds are presented.

INTRODUCTION

Cramp and Simmons (1980) note that after fledging, juvenile houbara bustard undergo a complete moult in which all feathers except a variable number of outer primaries and outer tail feathers are replaced by mid-winter. However, specific feather characteristics have not been described in sufficient detail to enable field workers handling houbara to separate first year birds from adults.

Similarly, male and female houbara cannot always be separated easily: although male houbara are significantly larger than females (by approximately 10%), the ranges of morphometric variables overlap between the sexes. Also, despite the feathers of the crown and neck ruff being described as shorter in females, the plumage of adult houbara does not show obvious sexual dimorphism, particularly during the non-breeding season (Cramp and Simmons 1980, Johnsgard 1991). Furthermore, while observation of the elaborate courtship display may indicate the gender of male houbara at certain times of the year, female houbara also perform this display sometimes. (Mendelssohn *et al.* 1979, Launay and Paillat 1990, Gaucher *et al.* 1996, Owen pers. comm.).

We present a preliminary guide for 'in-the-hand' age and sex determination of the *C. u. macqueenii* subspecies using data collected from birds in captivity. The moult sequence and the feather shape and pattern of wing and tail plumage of first year and adult birds are described, and recommended as criteria to ascertain age. For adult houbara, univariate morphometric data, and the results of discriminant analysis to classify gender, are

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presented. In future, it should be possible to establish the age of *C. u. macqueenii* (as either first year or adult birds) using plumage characteristics, and to establish the gender of those birds classified as adults (with a known degree of precision) using equations incorporating morphometric data.

METHODS

The study was conducted at the National Avian Research Center (NARC), now part of the Environmental Research and Wildlife Development Agency (ERWDA) of Abu Dhabi, United Arab Emirates (UAE). NARC is an ecological research organisation concerned primarily with the conservation of the houbara bustard and its habitat. NARC currently holds 190 captive houbara of the subspecies *C. u. macqueenii*. This race occurs from the Arabian Peninsula and north Caspian Sea, east to Mongolia (Cramp and Simmons 1980). Most of the houbara in NARC's care were translocated from Pakistan to Abu Dhabi, adult birds caught in the wild during the early 1980's, and were transferred to NARC in 1993.

State of moult was assessed and recorded for 10 male and 10 female adult houbara handled in April and September 1993, January and November 1994 and November 1995. The gender of these birds was ascertained surgically, using an endoscope. More generally, moult status was recorded for all birds by noting the presence or absence of moulted feathers in bird enclosures on a monthly basis. In November 1995, a photographic record was made of wing and tail feather plumage for five birds of each sex. Feather samples were collected at this time: feathers were removed by cutting the rachis with scissors, approximately 1cm above the feather follicle. Samples included: secondary 7, greater secondary covert 7, primary covert 6, primary covert 8, and outermost and second from outermost tail feathers.

For 16 houbara aged less than one year (hatched in 1995) the sequence of post-juvenile moult was recorded from July 1995 until April 1996. In November 1995, a photographic record was made of wing and tail feather plumage and feather samples were collected. Samples included: secondary 7, greater secondary covert 7, primary coverts 6, primary coverts 8, and outermost and second from outermost tail feathers.

In addition, the first author examined five free-living houbara caught in the Taukum Desert of Kazakhstan in May 1996. A photographic record was made of wing and tail feather plumage.

For 129 adult houbara (birds older than one year) of known gender (ascertained by endoscopy), the following measurements were taken by the first author using dial callipers: head length (see Fig. 1); culmen length (the chord from tip of upper mandible to root of feathering); tarsus length (see Fig. 2); middle toe length (the dorsal measurement from the joint with the metatarsus to the tip of the claw); and sternum length (the length of the keel from the xiphisternum to the cranial edge).

Discriminant analysis of the morphometric data to generate a discriminant function and equations to classify the gender of unsexed birds was performed using the SYSTAT statistical package (SYSTAT 1992). The discriminant function was a linear combination of the

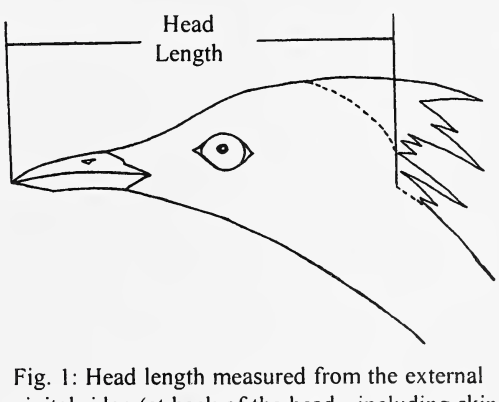


Fig. 1: Head length measured from the external occipital ridge (at back of the head - including skin) to the distal tip of the bill nail.

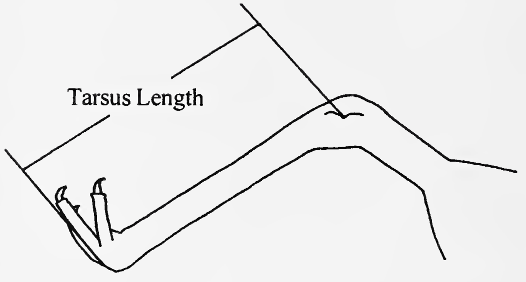


Fig. 2: Tarsus length measured diagonally on the outside edge of the left leg from the notch at rear of tarsometatarsus to the prominent edge formed when the toes are bent back approximately 90° to the tarsus.

morphometric variables, weighted so that the statistical difference between the sexes was maximised. The analysis was performed twice: once with all five morphometric variables, and once with two morphometric variables only (head and tarsus length).

Note that in the Results and Plates sections, 'juvenile' refers to post-downy plumage and 'adult' refers to the feather generation replacing juvenile, and all subsequent adult-like plumages. 'First adult' is used only in Plate 2, Fig. 4 to indicate the first post-juvenile generation of outer tail feathers.

Results

Age determination

Moult strategy - adult. Adult houbara underwent two moult cycles. Post-breeding (beginning late May/early June and continuing to late September), various body and tail feathers, followed by the elongated feathers of the crown, sides of neck and chest, were replaced. Primary moult began and progressed descendantly to primaries 5-8. Pre-breeding (beginning in November and continuing to March), the feathers of the sides of the crown, foreneck, hindneck and mantle were moulted and replaced by elongated plumes. Some belly, wing covert feathers and the outer primaries were renewed at this time.

Moult strategy - juvenile. Shortly after fledging, at the age of 2-3 months (July-August), moult began. Tail feathers were replaced centrifugally, beginning with the central pair, and a variable number were replaced before moult was suspended in September. Two to three secondary feathers were moulted ascendantly and lesser, median, and greater upperwing coverts were replaced in a random pattern. Primaries were moulted ascendantly and by age 3-4 months (August-September), primary feathers 3-6 had been moulted in all birds. Primary coverts were replaced either at the same time, or just after the primary feathers were shed. Moult was suspended for a variable period in autumn, but was usually resumed at age 6 months (late October to November), and proceeded with replacement of the feathers of the crown, sides of neck and chest (tracts of elongated feathering), and remaining juvenile tail, secondary and lesser, median and greater secondary covert feathers. In January, when birds were aged approximately 6 months, nearly all juvenile plumage had been replaced by an adult-like feathercoat. By April, nearly all birds had still not moulted a variable number of juvenile feathers including inner secondaries, greater secondary coverts, outer primaries and corresponding coverts and the feathers of the alula. Only one bird did not show any retained juvenile plumage in at least one of these feather groups. These data from captive first year birds indicate that retained juvenile feathering can be used to separate yearlings from adults up to April, when they are aged 10-11 months.

Of the five wild houbara caught and examined at a single display site in Kazakhstan in May 1996, one bird showed retained juvenile primaries 6-10 and primary coverts 6-10, some inner secondaries and the outer tail feathers. This bird was believed to be a yearling. In contrast, the other four birds showed complete adult-like plumage and were considered to be full-grown adults. This suggests that free-living yearlings are separable from adult birds at an age of approximately 12 months.

Jarrett N.S. & Warren S.M.: *Chlamydotis undulata macqueenii*

PLATE 1

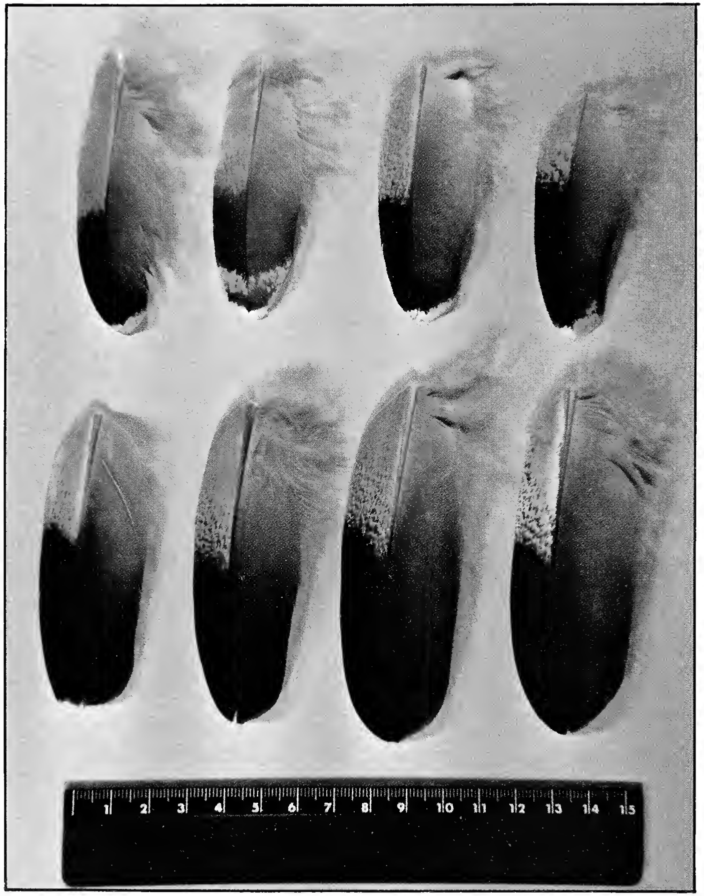


Fig. 1

Fig. 2

Fig. 1: Primary Covert 6. Juvenile (top), Adult (bottom). Pairs of feathers: female left, male right. Gender is tentative for juvenile.
Fig. 2: Secondary 7. Juvenile (top), Adult (bottom). Pairs of feathers: female left, male right. Gender is tentative for juvenile.

Jarrett N.S. & Warren S.M.: *Chlamydotis undulata macqueenii*

PLATE 2

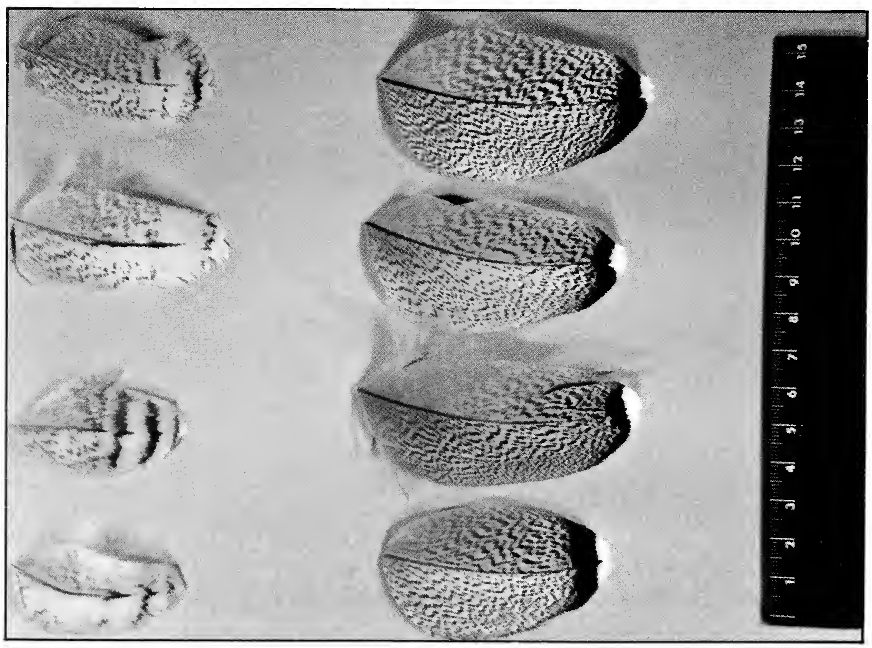


Fig.3

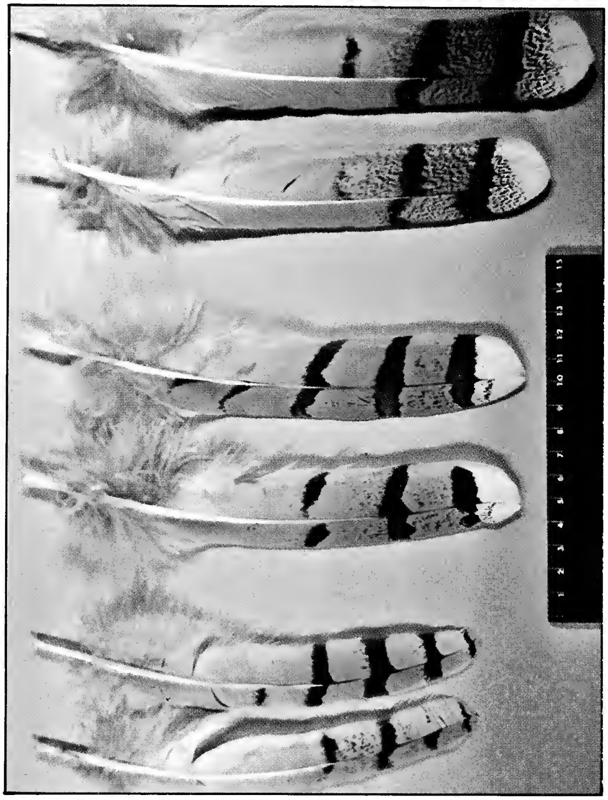


Fig. 4

Fig. 3: Greater Secondary Covert 7. Juvenile (top), Adult (bottom). Pairs of feathers: female left, male right. Gender is tentative for juvenile.
Fig. 4: Outermost Tail 1 & 2 (male). Juvenile (left), first adult (centre), adult (right). Gender is tentative for juvenile and first adult.

Jarrett N.S. & Warren S.M.: *Chlamydotis undulata macqueenii* PLATE 3

Fig. 5

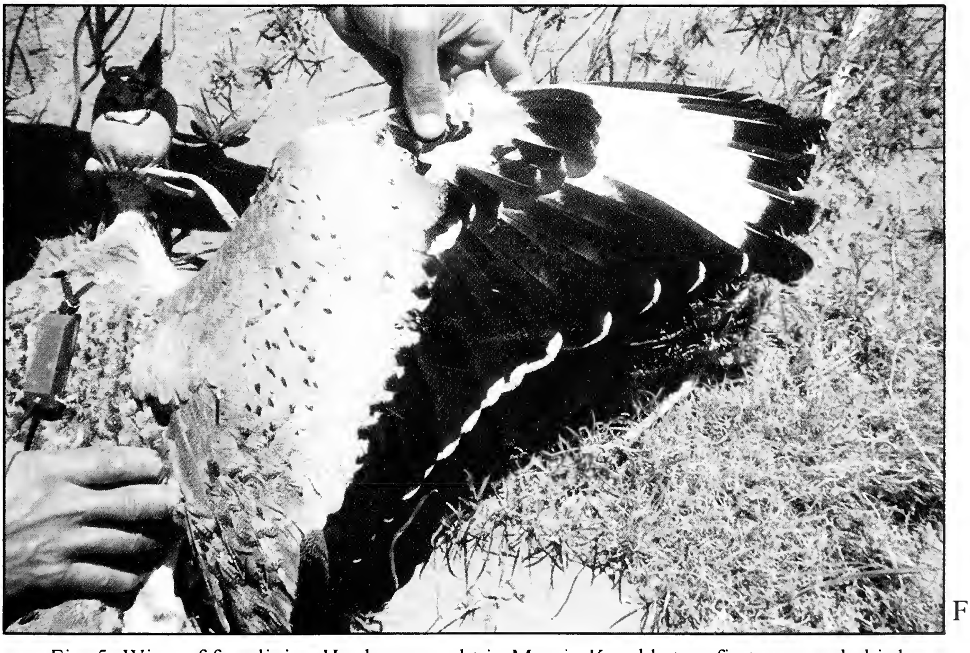


Fig. 6

Fig. 5: Wing of free-living Houbara caught in May in Kazakhstan, first year male bird (aged approximately 12 months). Retained juvenile primaries 6-9, primary coverts 7-9 visible.
Fig. 6: Wing of free-living Houbara caught in May in Kazakhstan and identified as an adult male bird. Note that inner primaries and their coverts are new.

The following differences in feather characteristics were apparent between retained juvenile and adult plumage.

OUTER PRIMARIES (not illustrated)

Juvenile - Short and narrow, with pointed tips when new. Bases to primaries 7-10 white, and distally, brownish-black with pale buff or cream-white tips and subterminal bars.

Adult - Long and broad. Bases white and tips black.

PRIMARY COVERTS (Plate 1, Fig. 1: Primary Covert 6)

Juvenile - Short, narrow and tapering. Muted dark-brown, palest on inner vane. Outer vane pale buff at the feather base, lightly flecked dark-brown. Inner vane fading from dark-brown to buff towards feather base. Cream to pale buff feather tip showing variable amounts of brown flecking.

Adult - Long and broad with rounded tip. Sooty-black, with buff-white to pale cinnamon bases. Vermiculated brown black and sometimes heavily, on pale areas of outer vane adjacent to solid dark areas.

SECONDARIES (Plate 1, Fig. 2: Secondary 7)

Juvenile - Short, narrow and tapering to a rounded tip. Dirty-brown with white tips, variable amounts of subterminal buff vermiculation with bases off-white on inner vane, pale buff on outer vane. On inner vane, small amount of brown vermiculation on pale area where this meets the dark area of the feather.

Adult - Long and broad, less tapered to rounded tip. Sooty-black with bases having brownish-white or cream inner vanes and pale buff outer vanes. New feathers sometimes show narrow white tip to feathers. On inner vane, variable amount of brown black vermiculation on pale area where this meets the dark area of the feather.

GREATER SECONDARY COVERTS
(Plate 2, Fig. 3: Greater Secondary Covert 7)

Juvenile - Narrow and tapering to a pointed and usually worn tip. Feathers translucent, pale buff or cream with variable patterning, ranging from narrow black vermiculation, to pale brown barring.

Adult - Broad with rounded tip. Pale cream to buff-white, finely vermiculated black. Black subterminal bar and white tips.

OUTER TAIL (Plate 2, Fig. 4: Outer Tail 1&2)

Juvenile - Narrow and tapering, usually to a worn tip, appearing more pointed than adult feathers. Faded cinnamon brown in colour with brown to black subterminal bar and whitish tip. Three to five (usually three) dark brown and often incomplete transverse bars. Cinnamon brown base colour is lightly vermiculated.

Adult - Broad. Buff coloured with a broad cream-white tip. Three dark brown (almost black) broad transverse bars with silver iridescence. The buff base colour is heavily vermiculated with black, between and near to the transverse bars. Sometimes, birds show vermiculation between white tip and first transverse bar, others have white of tip extending to outer transverse bar.

Plate 3, Fig. 5 shows the wing of the free-living houbara caught in Kazakhstan which was identified as a first year bird (aged approximately 12 months old). Note the combination of juvenile and (first-) adult primary coverts. Plate 3, Fig. 6 shows the wing of a free-living houbara caught in Kazakhstan and which was identified as an adult male bird.

Sex determination of adults

Of the 129 adult houbara for which gender had been determined using an endoscope, 79 individuals were identified as males and 50 were identified as females. There were significant

TABLE 1
MEASUREMENTS (MM) OF ADULT MALE AND FEMALE HOUBARA. MALE TO FEMALE (M:F) RATIO AND RESULTS FROM UNIVARIATE *t* TESTS ARE ALSO SHOWN

	Males				Females							
Variable	*n*	Mean	Range	*SD*	*n*	Mean	Range	*SD*	M:F	*t*	*df*	*P*
Head	79	103.65	97.2-110.4	2.75	50	95.01	89.2-100.1	2.35	1.09	19.03	116	<0.0001
Culmen	79	41.82	33.3-49.5	2.93	50	38.12	32.4-44.1	2.58	1.10	7.53	113	<0.0001
Tarsus	79	99.91	88.7-106.8	3.73	50	88.26	80.0-95.7	3.80	1.13	17.09	103	<0.0001
Sternum	78	104.61	83.4-114.6	5.61	49	91.04	80.1-99.8	4.62	1.15	14.80	115	<0.0001
Middle toe	78	47.58	35.0-57.4	4.27	49	41.51	33.8-48.4	3.57	1.15	8.63	115	<0.0001

differences between the sexes for each morphometric variable (Table 1, Fig. 3); males being, on an average, between 9% (head measurement) and 15% (sternum measurement) larger than females.

Discriminant analysis using all five morphometric variables correctly classified 99.2% of individuals: 100% of females and 98.7% of males; one male was misclassified. Fig. 4 illustrates the distribution of discriminant scores. The coefficients used to calculate the discriminant scores were as follows: culmen 0.058, head 0.595, tarsus 0.496, middle toe 0.157, sternum 0.364. The scores produced by these coefficients had overall zero mean and unit standard deviation within gender. Equations to classify the gender of unsexed birds using all five variables are shown in Table 2. A score is calculated for each gender, and classification is assigned to the gender with the highest score

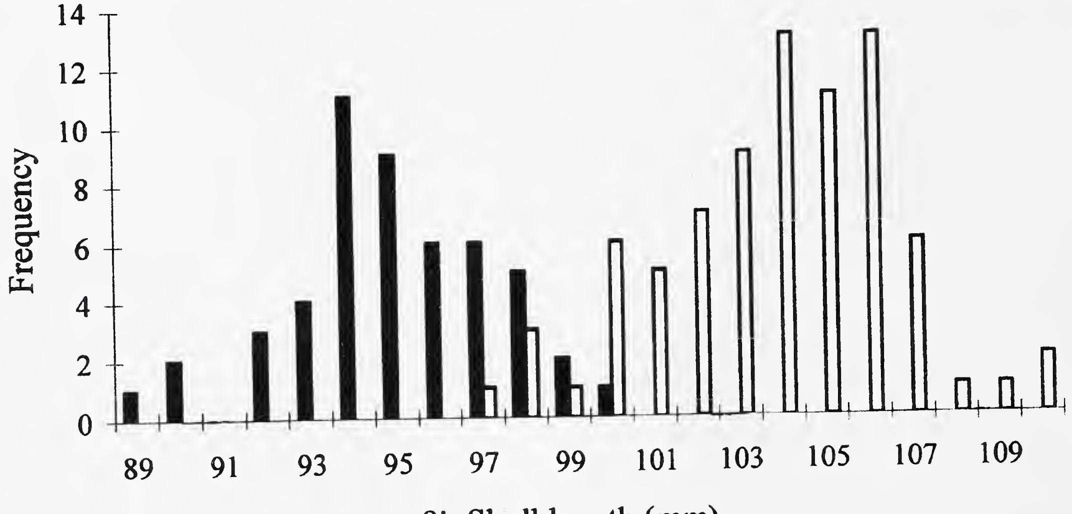
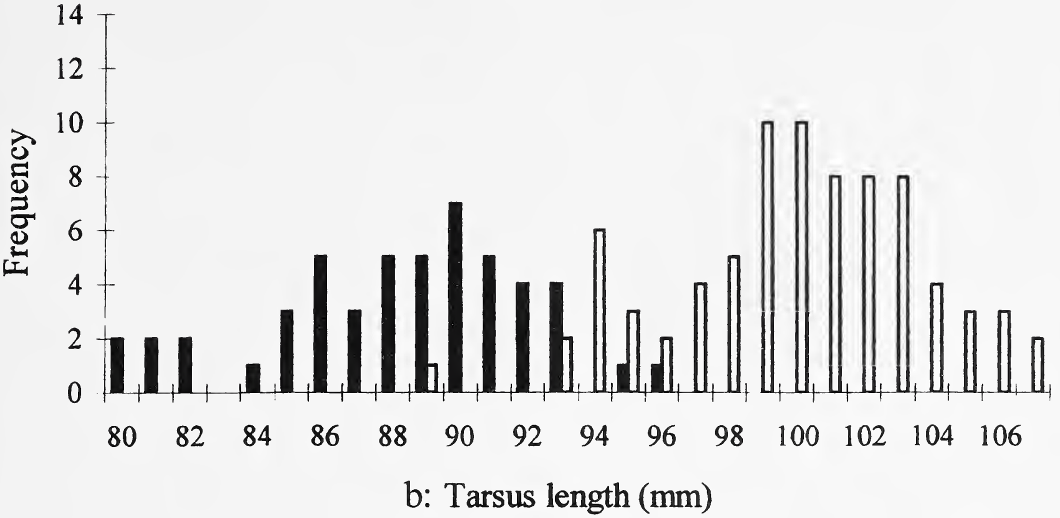


Fig. 3a: Frequency distribution of morphometric variable (skull length) for male (white bars) and female (black bars) for houbara.



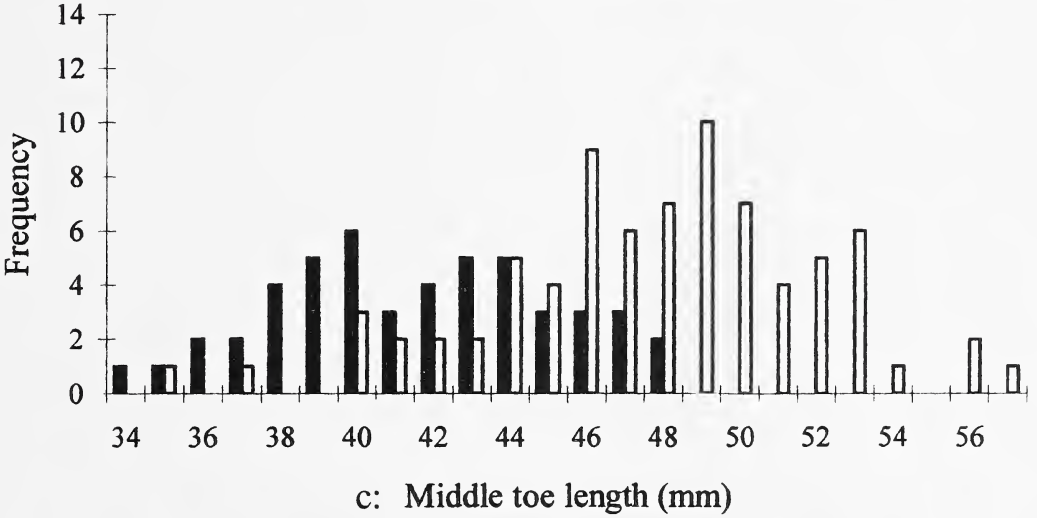


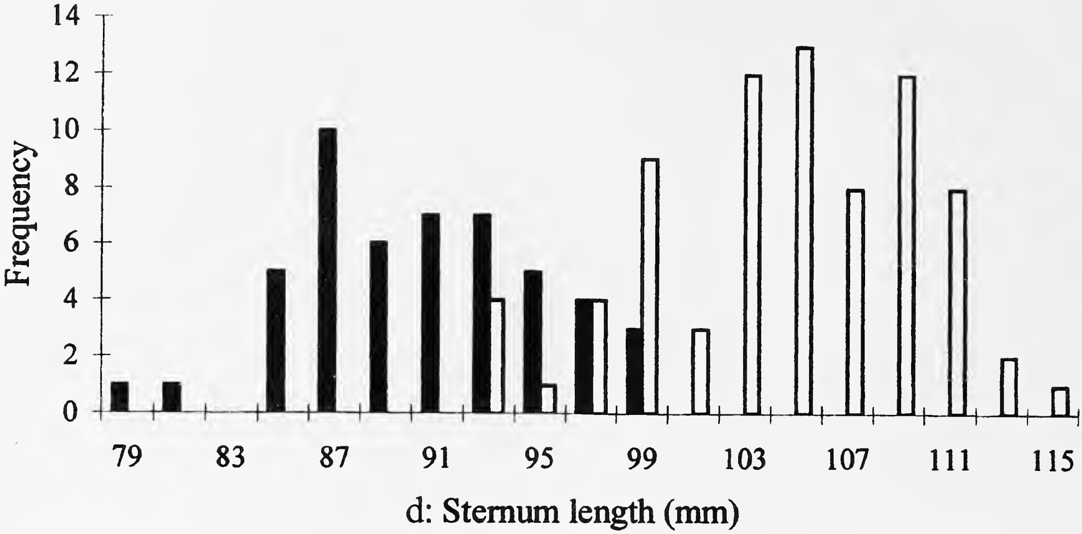
Fig. 3b and 3c: Frequency distribution of morphometric variables (tarsus length and middle toe length) for male (white bars) and female (black bars) houbara

(SYSTAT 1992). Head and tarsus length had the highest loadings on the classification equations.

Discriminant analysis using head and tarsus length only, also correctly classified 99.2% of individuals: 100% of females and 98.7% of males; one male was misclassified (the same male as above). Fig. 4 illustrates the distribution of discriminant scores. The coefficients used to calculate the discriminant scores were as follows: head 0.700, tarsus 0.643. Equations to predict the sex of unsexed birds using head and tarsus length only, are shown in Table 2.

Discussion

The ability to determine the age and sex of individual birds in a population can provide important information on aspects of



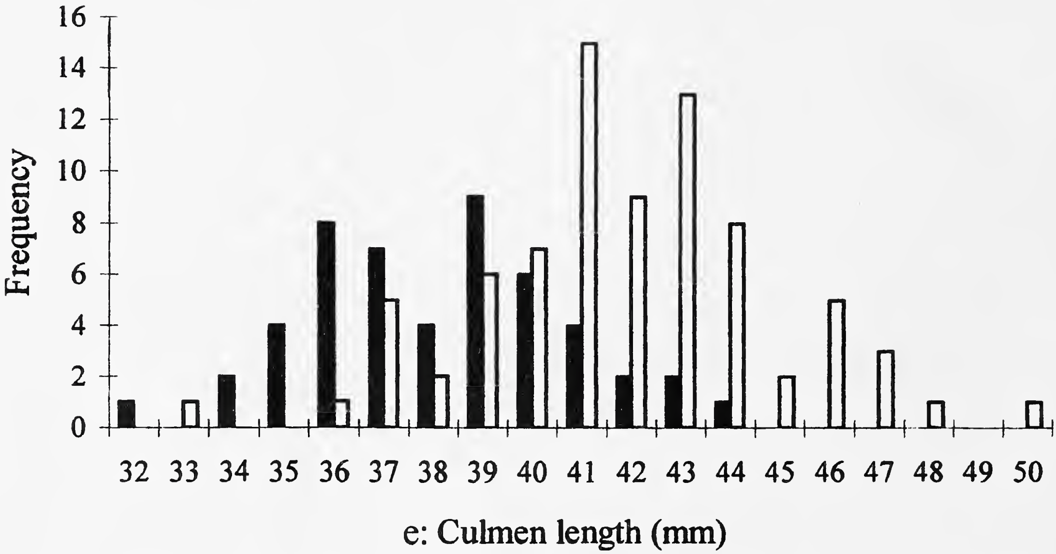
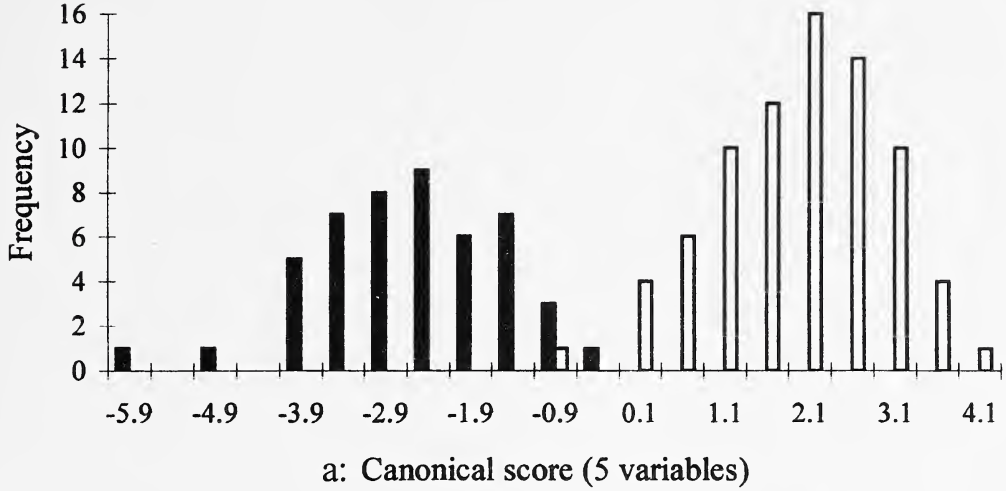


Fig. 3d and 3e: Frequency distribution of morphometric variables (sternum length and culmen length) for male (white bars) and female (black bars) houbara

reproduction, migration and population biology (Batt *et al.* 1992). Data on recruitment, survival and mortality are especially relevant for game species, where the ability to model the dynamics of a population accurately is vital, if harvest at a sustainable level is to be achieved (Hudson and Rands 1988). It follows that a technique for ageing and sexing of houbara could be useful to biologists examining live birds during marking operations or dead birds from hunters' bags.

We have shown that houbara in their first year retain juvenile feathers (various inner secondaries, greater secondary coverts, outer primaries and corresponding coverts, and outer tail feathers). The characteristics of these feathers can be used to separate first year from adult birds



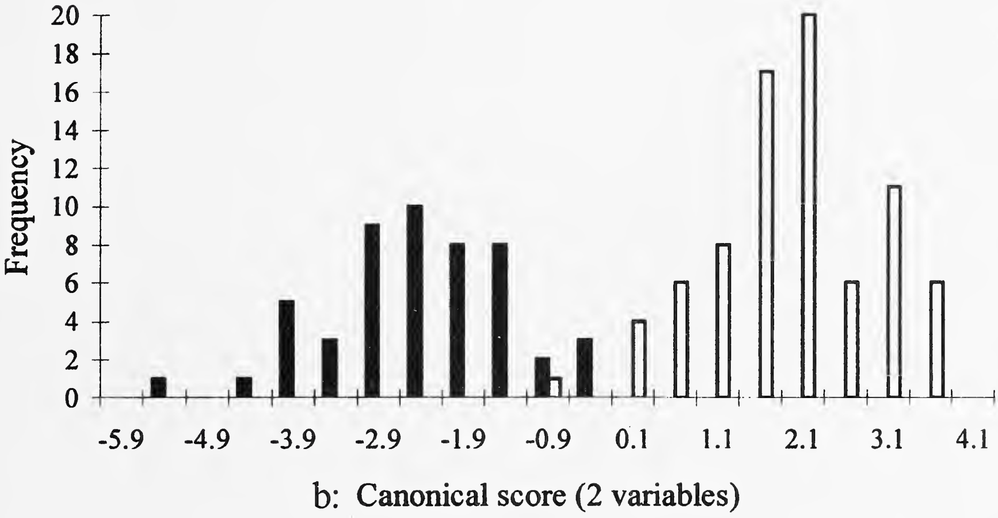


Fig. 4a and 4b: Frequency distribution of canonical scores derived from discriminant analysis on morphometric variables with respect to the gender of adult houbara (black bars - females; white bars - males). Discriminant scores derived using five variables (culmen, head, tarsus, middle toe and sternum length) (top), and two variables (head and tarsus) only (bottom)

relatively easily. Our experience with captive birds suggests that these feathers are retained for upto 10-11 months. Furthermore, it appears that some juvenile feathering is retained by free-living birds throughout the first year of life, as illustrated by the houbara caught in May in Kazakhstan.

It is possible that juvenile outer primaries and corresponding coverts are retained by some birds upto the age of 24 months. Cramp and

TABLE 2
CLASSIFICATION EQUATIONS TO PREDICT THE GENDER OF ADULT HOUBARA USING MORPHOMETRIC DATA: A SCORE IS CALCULATED FOR EACH GENDER, AND CLASSIFICATION IS ASSIGNED TO THE GENDER WITH THE HIGHEST SCORE (SYSTAT 1992). EQUATIONS GIVEN FOR PREDICTING GENDER USING FIVE VARIABLES (TOP), AND TWO VARIABLES ONLY (BOTTOM). MEASUREMENTS ARE IN MM.

No. of Variables	Gender	Equation
Five	Male	-1070.227 + 13.937(head) - 1.227(culmen) + 5.183(tarsus) + 1.698(sternum) + 1.064(middle toe)
	Female	-875.777 + 12.902(head) - 1.132(culmen) + 4.583(tarsus) + 1.382(sternum) + 0.883(middle toe)
Two	Male	-1045.982 + 14.371(head) + 6.017(tarsus)
	Female	-861.081 + 13.209(head) + 5.277(tarsus)

Simmons (1980) report that some retarded (late fledged) birds may not replace the outer primaries before their second winter. Therefore, care should be taken when ageing birds which have full adult-like plumage in autumn and early winter, but which show juvenile outer primaries (primaries 9-10) and corresponding coverts (primary coverts 9-10). It is probable that these individuals are second year birds, but clearly, further study of moult suspension and arrest in houbara is required.

By using discriminant analysis, the gender of adult birds was ascertained with a very high degree of accuracy. This method is superior to using a single morphometric variable, since the range of these overlap between the sexes (this study, and Cramp and Simmons 1980). We found that gender could be determined with the same degree of precision whether five or two variables were incorporated into the analysis. When attempting to ascertain the gender of adult houbara, it seems sensible to use the minimum number of measurements necessary, since this will minimise error arising from variation in measuring techniques (Barrett *et al.* 1989). It is therefore recommended that, to determine the gender of houbara, field workers use the equations incorporating head and tarsus length only.

There is evidence of a variation in body size across the range of *C. u. macqueenii*, for example, birds from Arabia have shorter wings, and wider and longer skulls, than birds from the Indian subcontinent (Osborne 1989). Therefore, care should be taken when attempting to ascertain the gender of houbara from outside the Pakistan sub-population, using the morphometric equations provided here (which are based on birds originating from Pakistan only). Clearly there is a need to collect morphometrics from throughout the range of this species, as this will enable more accurate sex determination within the different sub-populations.

It is likely that discriminant analysis of morphometric data can also be used to determine the gender of first year birds (although it will be important to take age into account when doing so). We have collected morphometrics from birds in their first winter, but at present the gender of these individuals is not known.

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OBSERVATIONS ON THE BEHAVIOUR OF GANGETIC DOLPHINS *PLATANISTA GANGETICA* IN THE UPPER GANGA RIVER[1]

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(*With one text-figure*)

Key word: Gangetic Dolphin, *Platanista gangetica,* Brahmaputra, Upper Ganga

The Gangetic dolphin (*Platanista gangetica*) occurs in Ganga and Brahmaputra river systems. Due to human activities like poaching and habitat destruction, dolphin populations in many rivers including the Ganga river have been depleted. A study on the ecology of dolphins in the Ganga river, Uttar Pradesh, was carried out during 1993-1995. Various behavioural aspects like feeding, surfacing, social behaviour and habitat utilisation of dolphins were studied through field surveys. These aspects, presented in the paper, are relevant to the conservation and management of dolphins.

INTRODUCTION

The Ganges dolphin (*Platanista gangetica*) is widely distributed in the broad and deep sections of the Ganga-Brahmaputra-Meghna river systems and their major tributaries from the foot of the Himalayas to the tidal zone (Jones 1982). It is found in India, Bangladesh, Nepal and Bhutan (Mohan 1989), but occurrence of dolphin in China is doubtful at present (Perrin and Brownell 1987).

Investigations on the ecology and distribution of the dolphin have been made since the early 1970's (Pilleri 1970, Kasuya and Haque 1972, Haque 1976). In recent years, studies have focused on the status of the dolphin in various rivers and their tributaries (Jones 1982, Pilleri and Tagliavini 1982, Gupta 1986, Shrestha 1986, Singh and Sharma 1985, Rao *et al.* 1988, Choudhury and Hussain 1992). Its habitat preferences in the Indus, Brahmaputra, Chambal and the rivers of Nepal were studied by Kasuya and Haque (1972), Jones (1982), Singh and Sharma (1985), Perrin and Brownell (1987) and Shrestha (1989, 1990).

Information on behavioural aspects of dolphin is scanty (Pilleri 1970, Kasuya 1972, Schnapp and Adloff 1986). Behaviour of dolphins in the Upper Ganga river has not been studied so far (Murti *et al.* 1991). We carried out a detailed ecological study of the dolphin *Platanista gangetica* during 1993-95 in the Upper Ganga river. Various behavioural aspects of the dolphin, which are important in the conservation management of the species, are presented in this paper.

STUDY AREA

We carried out the study along 645 km in the Ganga river between Rishikesh and Kanpur towns in Uttar Pradesh (Fig. 1). This stretch is shallow, with intermittent small stretches of deep pools and reservoirs upstream of barrages. The bank of the entire river stretch upto Kanpur is sandy and muddy, except between Rishikesh and Haridwar, which has riffle areas with rocky banks.

The climate of the study area is extreme during winter (end November to beginning of March) and summer (March to June). The

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Fig. 1: Map of River Ganga showing the sampling stations

Southwest monsoon arrives in end June and lasts till September.

Methods

Surveys were carried out regularly by boat and by walking along the riverside to locate dolphins, either through direct sightings or from the information gathered from people including fishermen. The survey method used by Singh and Sharma (1985), Rao *et al.* (1988) and Mohan *et al.* (1993) for dolphins was adopted to suit the study area. Intensive ecological study was carried out between Bijnor and Narora Barrage (165 km) where a good dolphin population was identified during a reconnaissance survey in December 1992.

Table 1

OCCURRENCE OF DOLPHINS DURING 1993-94 IN DIFFERENT ZONES OF RIVER GANGA: RISHIKESH TO KANPUR TOWNS

Zones	Distance (km.)	Presence
Rishikesh to Haridwar	0-29	Not recorded
Haridwar to Bijnor	29-129	Not recorded
Bijnor to Brijghat	129-213	Present
Brijghat to Narora	213-295	Present
Narora to Kachlaghat	295-362	Not recorded
Kachlaghat to Ghatiaghat	362-485	Not recorded
Ghatiaghat to Kanpur	485-645	One sighting

(Rishikesh = 0 km)

The study area was divided into different zones, considering the hydrological and other habitat characteristics (Table 1). Surveys were conducted every month in each zone on row boats along the middle of the river. Surfacing of dolphins was observed on both sides. In some areas the river was too shallow at midstream for the boat. So one bank of the river was traversed during the upstream survey and the other during the downstream survey. Field survey was conducted between 0600 h and 1800 h for one day for each zone during the first half of a month. In the second half of the month, detailed studies at some identified areas were conducted between 0600 h and 1800 h.

Dolphin sightings were recorded on maps prepared for the present study. The size, colour and behaviour were recorded whenever a dolphin was found. Habitat characteristics such as river width, depth, water temperature and flow were noted at the feeding and breeding grounds. The group size and sex ratio were recorded for each sighting.

The surfacing frequency and diving duration of calves, young and adults were noted

using a stopwatch. After observing them for long periods (1-2 hours), animals were divided into groups according to body size, colour, length of snout, and sex. Feeding behaviour of dolphins was studied by watching them for long periods at the feeding grounds.

Results

Population: Occurrence of dolphins in different zones is shown in Table 1. Of the seven zones surveyed, dolphins were observed in zones 3 and 4. Only one sighting of two young dolphins was recorded in zone 7 at Farrukhabad during September 1993. During 1993-94 and 1994-95, total populations of dolphin in the study area were estimated at 20 and 22 animals, respectively (Table 2). The population of 22 dolphins in 1994-95 comprised of eight calves, four adolescents, six females and four males.

Table 2
DOLPHIN POPULATION DURING 1993-94 AND 1994-95 IN RIVER GANGA BETWEEN RISHIKESH AND KANPUR TOWNS

Category	No. of dolphins in 1993-94	No. of dolphins in 1994-95
Males	4	4
Females	6	6
Adolescents	6	4
Calves	4	8
Total population	20	22

Behaviour

Surfacing: Surfacing of dolphins was observed during different times of the day. Surface jumps were recorded more than 150 times. In this, the beak appears along with the melon of the head, followed by the anterior part of the body. At Brijghat, Puth and Anupshahar, full jumps (the calves jump out completely from the water) were recorded. In the late evenings half jumps of adult dolphins were recorded, where only beaks and melon are exposed. During summer, side movement of an adult dolphin at a very shallow depth (50-75 cm) was observed 10 km downstream of Brijghat.

Feeding: More feeding was observed during the dry season. At Brijghat an adult dolphin was seen holding a fish measuring 5-7 cm in its beak at 0700 h on February 15, 1994. A similar observation was recorded in the early morning during January, April, and May 1994 at Karnabas. Garhmukteshwar and Puth, respectively. Their feeding on fishes near a fishing net was also seen at Puth on April 20, 1994. In the shallow waters, dolphins chased small fishes and caught them in large quantities. The food of dolphins reported in the literature is taken as a basis to identify the food availability in the study area.

Breeding: Adult sexes were differentiated by the length of the beak. The adult female has a longer beak than the adult male. During April 1993 two adult dolphins (male and female) making surface leaps together 4-5 times (courtship behaviour) were seen at Garh-mukteswar. During May 1994 similar behaviour was noted at Aharghat.

During the study period, ten adult dolphins (four males and six females) were recorded. During the 1993-1994 census, four calves were observed, whereas in the 1994-1995 census, eight calves were recorded. Since one female dolphin gives birth to only one calf per year, the birth of 4 calves in the study area indicated that of the 6 females observed, 4 were participating in the breeding. From the data on the calves, it is apparent that there were atleast four breeding females and 4 adult males in the population. The remaining two females were either non-breeding females or not breeding due to non-availability of a mate. Thus, the sex-ratio of breeding dolphins in the present study is 50:50. The dolphin population density in the study area was estimated at 1 dolphin per 9.1 km. The area has a high carrying capacity and can support more dolphins.

Migration: It was observed that dolphins move to much wider areas during the monsoon

season and retreat to some sections of the river at other times. During monsoon dolphins were distributed throughout the intensive study area i.e. Bijnor to Narora, a stretch of 165 km. When the river is flooded the dolphins get a good cover. Food is also available as fish breed in this season. During the dry season, due to decrease in the water level, dolphins migrate downstream and are concentrated between Brijghat and Narora in a stretch of 80 km. In this stretch, they get adequate water depth due to the release of water from the Kalagarh feeder canal and Bia river into the main Ganges.

Coexistence with other aquatic animals: The study area had, in addition to dolphins, two species of crocodile, *Gavialis gangeticus* and *Crocodylus palustris*, and twelve species of freshwater turtles. Around fifty species of wetland birds were also recorded at different stretches. Many of these animals are fish eaters and potential competitors for food. Some of the piscivorous birds, especially large groups of cormorants (*Phalacrocorax carbo*) are competitors with dolphin as they also prefer small fishes. River terns (*Sterna aurantia*) were always present where dolphins were feeding.

Discussion

Dolphins exhibit subtle and complex behaviour. They are social animals and live in small to large groups, associated with many animals like crocodiles, turtles and wetland birds. The behaviour of dolphins, particularly marine forms, has been known, both in nature and in captivity. Behaviour of the Ganges dolphin is less studied as its population is very small. Sightings are restricted to occasional glimpses. A significant contribution on dolphin behaviour is that of Pilleri (1970) who studied swimming, diving, blowing, leaping, flight and panic behaviour of *Platanista gangetica*.

The glimpses of surfacing dolphins in selected stretches of the river help in locating and counting them. By regular monitoring of a river stretch, all the surfacing dolphins can be counted according to the sizes, sexes and groups. This helps to assess the population of dolphins in various rivers.

Pilleri (1970) reported that injured and dead fish are not eaten by dolphins. Due to small beak size and the shape of the teeth, it is apparent that dolphins feed on small fishes only. To get sufficient energy, the animal has to feed on a large quantity of fish, so it always follows the shoals of fish available in shallow zones. The dolphin also chases small fish into shallow waters to catch them easily.

Breeding behaviour is important in the population growth of a species. Pilleri (1971) observed copulatory behaviour of *Platanista gangetica* during April in a tributary of Brahmaputra at a depth of 3 m. According to him, the dolphin pair came out of the water vertically, exposing half of their bodies for several seconds, with their bellies touching, before falling back into the water, to roll over together and lie approximately diagonal to the water line. In the Bijnor-Narora area, dolphins have a gestation period of 10-12 months, and give birth during March-April.

Dolphins do not stay in a particular location permanently, but move from one place to another for food, breeding or in search of proper cover (Jones 1982). The migration of dolphins has been broadly divided by earlier workers into two types; seasonal and local migration (Kasuya and Haque 1972, Jones 1982, Pilleri and Taglivini 1982, Singh and Sharma 1985 and Mohan *et al.* 1993). Pilleri and Taglivini (1982) reported that dolphins of Narayani river in Nepal migrate when the water level of Rapti river rises and is enriched by fishes and crustaceans. Mohan *et al.* (1993) recorded seasonal migration of dolphins in Brahmaputra river. According to them, dolphins ascend upstream during the flood. In Manas, Dikhow, Buridihing and Dansiri rivers they observed similar migration. Downstream movement of dolphins was also recorded by Kasuya and Haque

(1972), and Jones (1982) in the Brahmaputra, Meghna, and the rivers of Nepal.

Local migration of dolphins is a regular phenomenon. The fluctuation of number and group composition of dolphins at a particular area, and disappearance of dolphins from preferred places indicated local migration. It is assumed that such movement of dolphins is in search of food (Sinha 1993), to join other groups for breeding (Singh and Sharma 1985) or to avoid human interference.

Dolphins were observed between Bijnor barrage and Narora barrage. This is the only surviving population in the upper stretch of the Ganga river. According to Ballou (1995), small populations are challenged by a number of factors that increase the likelihood of their extinction. If a population is declining in number, and no action is taken to reverse the trend, then local extinction is imminent. This is applicable to the dolphins in the present study area. Protection to the small population between Bijnor and Narora barrages has to be given high priority. This will be better achieved if this river stretch is protected as a Dolphin Sanctuary. Necessary measures have to be taken to regulate the fishing activities and also to maintain water quality, to provide a suitable habitat for dolphins.

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MOULT IN SOME BIRDS OF PALNI HILLS, WESTERN GHATS[1]

BALACHANDRAN, S.[2]

(*With one text-figure*)

Key words: Moult, *Garrulax jerdoni*, laughing thrush, *Zosterops palpebrosa*, white-eye, *Muscicapa albicaudata,* verditer flycatcher, Palni Hills.

Bird ringing studies at Kodai Hills in winter and summer indicate that most of the resident species undergo a complete moult once a year soon after breeding (April-May), which is expected to be complete not later than August in all the species. Moult duration for three species, namely *Garrulax jerdoni, Zosterops palpebrosa,* and *Muscicapa albicaudata* were estimated. Smaller birds tend to have a shorter duration than larger species. Post-juvenile moult was observed in two species of bulbuls (*Pycnonotus jocosus* and *Hypsipetes madagascariensis*). Variation in commencing dates at different altitudes was also observed within a species.

INTRODUCTION

The seasonality of the Palearctic migrants passing through and wintering in the Western Ghats, and the life cycle of most of the resident species, are poorly understood. Bird ringing camps organised in different seasons in 1990-91 at Palni Hills by the Bombay Natural History Society provided valuable information on the seasonality of the wintering Palearctic migrants and the altitudinal movements of resident birds. Based on the data collected on moulting of some resident species of Palni Hills during November 1990 and April to June 1991, an attempt been made to study primary moult and its duration.

STUDY AREA

Kodaikanal hills are situated at an altitude of 2100 m on the easternmost tip of the Palni Hills, an off-shoot of the main Western Ghats. A circular main road begins from Kodaikanal (10° 41' N, 77° 29' E), passes through Gundar, Poomparai, Paricombai, Mannavanur, Berijam, Mathikattan Shola, Pillar rock and ends at Kodaikanal. Bird netting was carried out on either side of the road upto 4 km before and after Poomparai, which lies about 20 km from Kodaikanal on the ring road. Poomparai village is surrounded by cultivated land, with plantations of *Pinus, Eucalyptus* and *Acacia* spp. Natural primary forest is restricted to isolated pockets and at the edges of two plantations. Diverse microhabitats such as *shola* pockets, primary forests, scrub jungle, clear felled areas with secondary growth and various plantations (acacia, pine, and eucalypt), provide for a great abundance of birds. The remnant original forests and the clear felled area with secondary growth are ideal for netting. The exotic weed *Eupatorium* occurs in patches.

The other areas covered with netting were Berijam on the ring road at an altitude of about 2500 m, and Marian *shola* and Pulavachar which lie 10 km and 18 km away from Berijam, on the Berijam-Munnar Road before Top station. Very good *shola* patches are found in Berijam and Marian *shola.* At Pulavachar most of the primary forests have been cleared for plantation.

Netting was also carried out at the moist deciduous forests around Oothu and Pannaikadu

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area situated at an altitude of 1000-1100 m between Battlagundu and Kodaikanal. Plantations adjacent to these forests were mainly coffee and orange.

Methods

Birds were netted with mistnets from November 5 to November 20, 1990 and April 20 to June 7, 1991 (summer). All the birds caught and handled for ringing were examined for moult. Though netting was not done for the full month in April and June, the birds caught during the last week of April, and first week of June were taken as the samples for summer. The birds examined for moult during November were taken as the samples for winter.

Primary feathers were numbered from distal (1) to proximal (10), including the much reduced distal primary, making a total of ten primaries. Similarly, eight secondaries were also numbered. The primaries, secondaries and the rectrices (12 in number) were examined for moult which was recorded on separate moult cards by assigning each primary and secondary feather an integral score between '0' (old feathers) and '5' (full grown feathers). The British Trust for Ornithology (BTO) notation was adopted (Snow

Table 1
NUMBER OF BIRDS IN MOULT IN DIFFERENT MONTHS

Species	April			May			June		
	Total caught	Birds in moult		Total caught	Birds in moult		Total caught	Birds in moult	
		Wing	Tail		Wing	Tail		Wing	Tail
Garrulax jerdoni	77	5	16	110	23	24	33	26	24
Zosterops palpebrosa	77	-	7	70	12	2	20	11	6
Megalaima viridis	8	-	-	5	1	-	9	5	-
Pycnonotus jocosus	23(A)	-	5	18(A)	-	4	8(A)	-	-
	2(J)	1	-	1(J)	1	-	3(J)	2	-
Muscicapa albicaudata	23	-	-	20	1	1	4	1	-
Pomatorhinus schisticeps	4	-	-	3	-	1	2	2	-
Culicicapa ceylonensis	4	-	-	5	3	-	-	-	-
Parus xanthogenys	5	-	2	1	-	1	2	1	-
Brachypteryx major	26	-	1	38	-	-	-	-	-
Chrysocolaptes lucidus	-	-	-	2	2	-	-	-	-
Hypsipetes indicus	-	-	-	7	4	-	2	-	-
Hypsipetes madagascariensis	9(A)	1	1	-	-	-	1	1	1
	3(J)	1	1	1(J)	1	1	-	-	-

Note (A) = Adult (J) = Juvenile

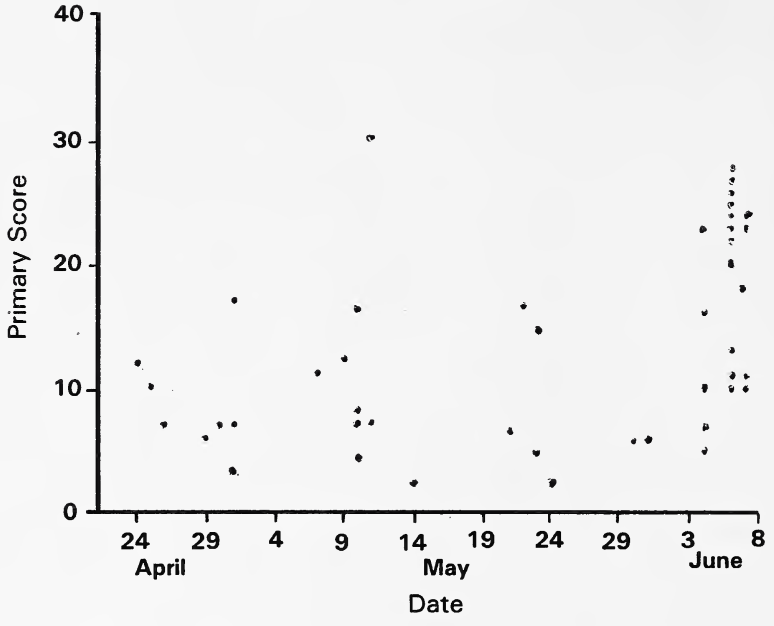

Fig. 1: Progress of primary moult in *Garrulax jerdoni*

1967) for scoring. A score of '1' was given to a feather missing or in pin, '2' '3' and '4' to one-third, two-thirds, and nearly full grown feathers. The scores for all the ten primaries and eight secondaries of each wing were then added separately to get a primary moult score with a maximum of 50 and a secondary score of 40.

Moult scores of different individuals of laughing thrush were plotted against the dates of capture to estimate the duration, starting, and ending dates of moult. Duration of moult was also calculated from the rate of feather growth of an individual bird caught more than once during its moulting period. Secondary scores of a few species were plotted against the primary score, to establish the relation between primary and secondary growth.

Generally, the word 'moult' denotes primary moult unless otherwise mentioned. As the data collected were from the earlier stage of the moult, the commencing date of the moult is evident from this study.

White-breasted Laughing thrush *Garrulax jerdoni*: The first adult bird in primary moult was obtained with the score of '12' on April 24. However, among the 33 adults caught during the first week of June, 21% had yet to commence the moult. Moreover, the moulting individuals had wide variation in moult score. This indicates that the commencing date of primary moult also ranged from mid-April to mid-June (Table 1 and Fig. 1)

Among 57 moulting birds, the only individual seen with arrested moult was also the one with the maximum score (30). It was caught on July 11. The birds observed with a moult score between 20 and 30 in early June must have commenced moulting in mid-April. Since the laughing thrush had obtained 50% of the primary moult score in seven weeks (mid-April to early June) it could be expected to complete the moult in another seven weeks i.e. by the end of July. Possibly, the moult duration for this species was around 100 days (14 weeks).

TABLE 2
NUMBER OF GROWING PRIMARIES IN DIFFERENT SPECIES

Species	No. of birds in moult	No. of primaries in growth 1	2	3	4	5
Garrulax jerdoni	57	15	33	7	2	-
Zosterops palpebrosa	19	6	11	1	-	1
Megalaima viridis	6	1	5	-	-	-
Pycnonotus jocusus	3	1	2	-	-	-
Muscicapa albicaudata	3	1	2	-	-	-
Pomatorhinus schisticeps	2	-	2	-	-	-
Parus xanthogenys	1	1	-	-	-	-
Culicicapa ceylonensis	3	-	1	1	1	-
Chrysocolaptes lucidus	2	2	-	-	-	-
Hypsipetes indicus	3	3	-	-	-	-

Moult duration calculated on the rate of growth from retrapped birds varied between 100-116 days. Though the number of primaries growing concurrently varied from 1 to 4, most moulting individuals were observed with two primaries growing concurrently followed by one.

In all individuals, secondary moult commenced while the primary moult was in progress. Generally, like the secondary moult, the tail moult started after the commencement of the primary moult. However, in some individuals, tail moult preceded the primary moult.

Among 130 young birds examined for moult, post-juvenile moult was not noticed till early June.

White-eye *Zosterops palpebrosa*: In this species, the primary moult commences from the first week of May. It was evident that all the 71 adults caught and examined for moult during April had not commenced moulting. Though the commencing date is two weeks later than that of the laughing thrush, 45% of the adults caught in the first week of June were yet to commence their moult. Birds with a moult score between 20 and 30 in early June might have started the moult in early May, and could be expected to complete it by early July. Hence, the duration would be 8-9 weeks.

An unmoulted adult caught on April 20 was retrapped with a score of '19' on May 22. Since the score had increased from '0' to '19' within 30 days (assuming that it had commenced moulting a day after the first capture), based on the rate of growth, the duration should be less than 79 days. As none of the birds was seen in primary moult till the end of April, it must have commenced in the first week of May at the earliest, in which case the duration would be around 58 days. ·

The secondary moult was noticed after the primary score reached '15'. Tail moult was observed in some individuals before the primary moult had started. The number of primary feathers in growth varied from 1 to 3. The majority of moulting birds were seen with two feathers in growth (Table 2).

Small green barbet *Megalaima viridis*: A total of 25 adults were caught from Poomparai (high altitude) and Pannaikkadu (lower altitude) area. Out of them, six were moulting. The birds

caught till the middle of May at Poomparai were yet to begin moulting. The two birds caught on May 21 and June 7 had a moult score of '3' and '6' respectively. Out of the seven individuals caught on June 2 at Pannaikkadu, four were in moult, with a score varying between '6' and '26'. The moult commences in the third week of May at Poomparai; at Pannaikkadu it is perhaps much earlier than at Poomparai. Out of six moulting birds, five were observed with two primaries growing concurrently (Table 2). The duration could not be calculated as the sample was small.

Nilgiri Verditer flycatcher *Muscicapa albicaudata*: Out of the 47 adults caught between late April and early May, only three birds were in moult. The first such bird was obtained on May 17 with the score of '22'. The other two were caught in the first week of June and had a score of '26' and '29'. This shows that only a small population of this species undergoes moult in May and June, and the majority of the population will moult at a later date. However, the rate of growth calculated from a retrapped individual indicated that the moult was fast and its duration short. In a 40 days interval, the increase in score was '29'. Assuming that the moult had commenced the day after its first capture, the duration would be less than 69 days.

Greyheaded flycatcher *Culicicapa ceylonensis*: Among the nine adults, the first six caught between late April and early May had not commenced moulting. The remaining three, caught between May 14 and 21, had scores of '11' and '12'. This indicates that the species commences its primary moult in early May.

Scimitar babbler *Pomatorhinus schisticeps*: Seven birds caught in April and May had not commenced moulting, but the two birds netted on June 5 and 6 had a moult score of '6', indicating that the moult commences by the end of May or early June.

Yellow-cheeked tit *Parus xanthogenys*: Out of the eight individuals netted between April and early June, only one caught on June 7 was moulting and had a moult score of '9', indicating that moult must have commenced at the end of May.

Tickell's flowerpecker *Dicaeum erythrorhynchos*: Four adults were netted during the study period. Adults in April and May had an advanced moult score between '35' to '45' and the one caught in early June had completed its moult.

Larger goldenbacked woodpecker *Chrysocolaptes lucidus*: Two birds caught on May 18 at Oothu were in moult, with a score of '19' and '22'.

Yellowbrowed bulbul *Hypsipetes indicus*: Out of the seven birds caught on May 18 and 19, four were in moult with the score between '9' and '15'. The two birds caught in the first week of June had yet to commence moulting.

Black bulbul *Hypsipetes madagascariensis*: An adult bird with a score of '9' on April 23 was the only moulting bird among the nine examined in the same month. The only adult caught in June had a score of '18'. Among the four juveniles, two were in post-juvenile moult.

Redwhiskered bulbul *Pycnonotus jocosus*: A total of 49 adults and six juveniles were caught and examined between April and early June. Till June 7, none of the adults had commenced wing moult. A few adults were observed in tail moult. Post-juvenile moult was observed from April. Out of the six juveniles examined in three months, four were in moult with scores ranging from '5' to '20'.

Other species: The only grey jungle fowl *Gallus sonneratii* netted on May 18 had a score of '14'. Among the two spotted doves *Streptopelia chinensis*, one had arrested its primary moult after renewing four inner primaries. The white-bellied shortwing *Brachypteryx major albiventris* one of the commonest species in the Kodai hills, had not commenced wing moult till June 7. In the 65 adult birds, only tail moult was noticed in some individuals. The other common species of Kodai

hills not observed in moult were the blackbird *Turdus merula,* jungle myna *Acridotheres fuscus* and black-and-orange flycatcher *Muscicapa nigrorufa.*

Discussion

The studies at Palni Hills in winter and summer indicate that most of the resident species undergo a complete moult once a year, soon after their breeding in summer. Moulting is completed between July and August in all the species, as most of them are in partial primary moult till early June, while in November all the species seen have fresh as well as slightly worn primaries. This indicates that primary feathers must have been renewed two to three months earlier, that is before the end of August. Probably the same primaries were retained till April and May, by which time they became frayed with age. As the post nuptial moult is expected to be completed between July and August, it is clearly not possible for them to undergo another moult before November. The fresh primaries observed during November and the old primaries about to be renewed in April confirmed that there was no moult from December to March. Thus this study clearly shows that the birds of the Palni Hills have a definite period (April to August) to complete their moult after breeding (February to April).

Feather replacement: Though the commencement date of the primary moult varied between species and also between individuals of the same species, the pattern of feather replacement in individuals of all the species was the same. They started from the innermost primary and progressed outwards. The secondary feathers generally started from the outer feather and progressed inwards initially, and later from the middle and the innermost secondaries also. Tail feathers also generally commenced from the middle feathers and progressed both ways, but in some individuals the feather replacement was irregular.

The same kind of regular replacement was observed in the post nuptial and post-juvenile moults of the resident birds of Tirupati Hills of the Eastern Ghats, especially in three species of bulbuls namely whitebrowed (*Pycnonotus luteolus*), redvented (*P. cafer*) and redwhiskered (*P. jocosus*) (Balachandran *et al.* 1995). However, in the resident birds of Point Calimere, even within the same species (*P. luteolus*, *P. cafer*), the feather replacement was irregular and birds with moult were observed throughout the year (unpublished data). This may be due to the absence of definite breeding seasons at Point Calimere, where both species breed throughout the year. However, at Tirupati and Kodai Hills all birds complete breeding in a particular season and undergo a post-nuptial moult soon after breeding.

Commencing date: Variation in commencing date among the species may be due to the variation in the breeding season. The most common species, the white-breasted laughing thrush, was probably the earliest breeder among the resident species, and also had the earliest commencing date (mid-April). From the status of the brood patch, it was inferred that a smaller population of the birds caught in April were brooding and attending the nest. In May, very few birds had a brood patch, and the proportion of young birds was high in late May and early June.

Other species which commenced moulting in April included the Tickell's flowerpecker. Scimitar babbler and yellow-cheeked tit were the late moulting species, they commenced moult at the end of May. The non-moulting species during the study period were the blackbird, black-and-orange flycatcher, white-bellied shortwing and redwhiskered bulbul (only adult).

The commencing date of moult for the small green barbet was seen to vary at different altitudes. Birds from lower altitudes commence moulting much earlier than high altitude forms. This may be due to the abundance of food, especially *Ficus* sp., the favourite fruit of many birds commonly found at low altitudes.

Moult duration: The moult duration mainly depends upon the rate of feather growth. It appears that smaller birds tend to have a shorter duration than bigger birds. Among the estimated duration for three species (laughing thrush, verditer flycatcher and white-eye), the smallest bird (the white-eye) had the shortest duration (58 days) and for the largest bird (the laughing thrush) it was around 100 days. The duration for the verditer flycatcher, which is larger than the white-eye, and smaller than the laughing thrush, was around 70 days.

Arrested moult: Arrested moult is likely to lengthen the total duration of moult, which also enables long distance migrants to make use of partly new and therefore efficient full wing (Kozlova in Pienkowski 1976). Arrested moult was noticed in only two individuals among all the species at Kodai Hills. As these birds are breeding residents, they have no need to maintain a full wing by arresting the moult to fly long distances. Hence, they probably maintain a continuous feather growth.

Moulting and breeding do not overlap, as the moult starts after breeding. This is evident from the condition of the brood patch.

The post-juvenile moult has been observed only in redwhiskered and black bulbuls. Similar post-juvenile moult occurs in three species of bulbuls (whitebrowed, redwhiskered, and redvented) one month after breeding at Tirupati Hills (Balachandran *et al.* 1995).

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DISTRIBUTION OF AQUATIC INSECTS IN A SMALL STREAM IN NORTHWEST HIMALAYA, INDIA[1]

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Key words: Northwest Himalaya, stream insects, species composition, microhabitat, species diversity index.

This article deals with species composition, annual variability, microhabitat preference and species diversity index of aquatic insects in a perennial stream in northwest Himalaya, during 1989-91. A total of 62 morphospecies belonging to Ephemeroptera, Odonata, Plecoptera, Hemiptera, Megaloptera, Coleoptera, Trichoptera and Diptera were caught in the samples. Some of these showed a marked preference for particular microhabitats within a short span of the stream. Nymphs of mayflies, *Baetiella tuberculata* (Kazlauskas) and *Baetiella* sp., and the larvae of dipteran *Horaia* sp., preferred stony substrate with fast water current. Burrowing nymphs of mayfly *Caenis* sp., and the stoneflies *Amphinemura rahungi* Aubert and *Nemoura* sp., predominated in sand and silt deposited between gravel and rubble. Nymphs of *Ecdyonurus, Epeorus* and *Ephemerella* (Ephemeroptera) were mainly associated with gravel-rubble and also loose stones. Filter feeders, like larvae of *Cheumatopsyche columnata* Martynov (Trichoptera) and some species of *Simulium* (Diptera) were abundant in the gravel-rubble as it provided suitable substratum for attachment of their nets and bodies. The gerrid bugs *Chimarrhometra orientalis* (Distant) and *Metrocoris compar* (Buchnan White), and the gyrinid beetle *Orectochilus murinus* Regimbart, were mainly found in sheltered midstream pools by the side of large rocks. Mean monthly species diversity index varied little between two years, i.e. 2.13 and 2.66 for 1989-90 and 1990-91 respectively.

INTRODUCTION

The stream environment is complex and heterogeneous, having many habitat patterns, primarily due to a wide range in the size of substrate particles and configurations on the stream bed, different kinds of microcurrents and a variety of available food. These habitats are characterised by a high diversity of aquatic insects. There are considerable differences in insect distribution between various sections along the course of a stream and also at microhabitat level (Williams and Feltmate 1992). Considerable information is available on the distribution and other ecological aspects of stream insects in Europe and North America, as reviewed by Hynes (1970), Resh and Rosenberg (1984), and Williams and Feltmate (1992). Flowers (1991) has dealt with the insect diversity of Central American rivers. But such studies on Indian stream insects are sparse and limited to the works of Annandale and Prashad (1919), Gupta and Michael (1983), Julka *et al.* (1988), Arunachalam *et al.*(1991), Balasubramanium *et al.* (1992) and Burton and Sivaramakrishnan (1993).

The objective of this investigation was to study species composition, annual variability, specific niche preference, and species diversity index of insects in a stream in northwest Himalaya.

STUDY AREA

Himachal Pradesh (between 30°23'-33°12' N lat., 75°37'-79°04' E long.) falls in the northwest Himalaya. The entire area is drained by an intricate network of springs, streams and rivers. A spring-fed perennial stream in the Barog Hills (Dist. Solan) was selected for the

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present study. It flows southeastwards to discharge into the Raboun tributary of the Giri-Yamuna drainage. The area has four distinct seasons: spring (late February to April), summer (May to August), autumn (September to middle of November) and winter (middle of November to middle of February). A distinct wet summer period during the southwest monsoon months of July-August is distinguished from summer in May-June. Total rainfall during 1989-90 and 1990-91 was 1404.7 mm and 993.4 mm respectively.

The study area is a small riffle close to the source of the stream near Barog railway station (7 km from Solan; altitude 1500 m above msl. 30°55 'N lat; 77°06 'E long.). The riffle is 0.5-2.6 m wide and 5-15 cm deep. It flows through a narrow valley, largely exposed to sunlight. Its substrate comprises gravel, rubble and boulders, and granite rocks. A considerable amount of sand is deposited in the interstices of gravel and rubble. Various physico-chemical characteristics of the stream are given in Table 1.

Riparian vegetation comprises trees of *Pinus roxburghii*, *Eucalyptus* sp., *Quercus leucotrichophora*, *Morus alba* and *Pristacia intergrimma*; small shrubs like *Utrica dioco*, *Pinsepia utilis*, *Rubus ecipticus* and *Carrisa caranda*. Prominent herbs on the banks of the stream are *Targetes minuta*, *Ipomea* sp. and *Salvia lanata*.

Table 1
PHYSICO-CHEMICAL CHARACTERISTICS OF A STREAM AT BAROG (H.P.)

Characteristic	Range	Average
Current velocity (m s^{-1})		
Rocky substratum	0.27 - 1.45	0.71 ($\pm$0.31)
Gravel-rubble/loose stone substratum	0.37 - 1.08	0.47 ($\pm$0.18)
Flow (cm^3 s^{-1})		
Rocky substratum	8.50 - 114.70	38.00 ($\pm$30.43)
Gravel-rubble/loose stone substratum	9.90 - 93.50	30.06 ($\pm$24.81)
Surface temperature (°C)	10 - 25	16.60 ($\pm$ 4.98)
Dissolved oxygen (mg l^{-1})	2.52 - 10.70	4.99 ($\pm$ 1.61)
Free carbon dioxide (mg l^{-1})	0 - 6	0.74 ($\pm$ 1.59)
Total alkalinity (mg l^{-1})	96.75 - 125.00	114.21 ($\pm$ 6.94)
Specific conductivity (u mhos)	25 - 96	33.85 ($\pm$ 5.09)
pH	7.8 - 8.5	7.99 ($\pm$ 0.20)
CPOM (mg m^{-2})	0.63 - 12.84	3.28 ($\pm$ 0.17)
FPOM (mg m^{-2})	1.33 - 59.50	15.38 ($\pm$ 1.01)

Material and Methods

The benthos were sampled monthly by quantitative and semiquantitative methods from June, 1989 to May, 1991. Different microhabitats arising from physical changes in the substratum of the riffle were sampled: Site I with rocky bottom, Site II with gravel, Site III with loose stones and Site IV comprised small midstream pools with slow flow of water. Semiquantitative samples were obtained by operating a hand net (30 cm diam., cloth mesh 0.4 mm) for about 45 seconds in each of three pools, and by picking and washing 20 loose stones (diam. 15-20 cm). Quantitative samples were taken with a Surber's sampler (25 cm^2 area; mesh opening — 0.4 mm) at places with almost level rocky and gravel strata. The Surber's sampler was operated by the method of Welch (1948). On each occasion, 6 replicates were obtained. The area sampled exceeded 0.3 m^2, which is considered satisfactory for normal quantitative purposes by Dudgeon and Richardson (1988).

The water surface temperature was taken with a standard mercury celsius thermometer. Current velocity was determined by timing a float in midcurrent. The volume of flow, dissolved oxygen, carbon dioxide and total alkalinity were estimated by methods given in Welch (1948). The pH was recorded with a pH meter (Model AMK 1020A AMKAY) and conductivity readings were taken with a conductivity meter. The coarse particulate organic matter (CPOM; >1mm) and fine particulate organic matter (FPOM; <1mm)

were estimated following the methods in Ernst and Stewart (1986).

OBSERVATIONS

Faunal composition

In all, 62 morphospecies of insects were collected from the Barog stream during the sampling period. These belonged to 8 major groups: Ephemeroptera, Odonata, Plecoptera, Hemiptera, Megaloptera, Coleoptera, Trichoptera and Diptera. Relative densities of major groups at four sites are shown in Table 2. Ephemeroptera, Trichoptera and Diptera were co-dominant on the rocky substratum and in gravel/rubble section. Among nondominant groups, only Coleoptera and Plecoptera had a significant presence in gravel-rubble. The insect fauna on loose stones was dominated by the larvae of Trichoptera, followed by Diptera and Ephemeroptera. Dominant insect groups in midstream pools were semiaquatic Hemiptera on the water surface and Coleoptera in the water column. Larvae of Ephemeroptera, Trichoptera and Diptera were also present in significant numbers.

Annual variability

The number of taxa varied little over the two years of the present studies (Table 3). However, relative densities of numerically dominant (>1% of the total number collected) species of the mayflies *Baetis*, *Ecdyonurus* sp.1 and *Epeorus*, the stonefly *Nemoura*, and the blackfly *Simulium* (*Simulium*) *digitatum* and *Simulium* (*Simulium*) sp. increased significantly from the first (1989-90) to second year (1990-91). On the contrary, these values declined substantially from first to second year in case of chironomids like *Pentaneura* sp., *Cryptochironomus* sp., and trichopterans like *Agapetus triangularis* and the Lepidostomatidae.

Variability between sites

Relative densities of all morphospecies at different sites are presented in Table 3. Within Ephemeroptera, *Baetis* sp. 1 attained greatest abundance on rocky substratum (34.43%) and in gravel/rubble (16.19%) sections of the riffle. *Baetiella tuberculata* and *Baetiella* sp. were

TABLE 2

RELATIVE DENSITY (%) OF INSECT GROUPS IN A HILL STREAM AT BAROG IN 1989-90 AND 1990-91

Site	Rocky substratum		Gravel/Rubble substratum		Loose stones		Midstream pools	
	(Site I)		(Site II)		(Site III)		(Site IV)	
Order	1989-1990	1990-1991	1989-1990	1990-1991	1989-1990	1990-1991	1989-1990	1990-1991
Ephemeroptera	50.2	53.5	29.4	41.0	11.8	12.4	16.6	13.8
Odonata	-	-	0.7	0.4	-	0.1	-	-
Plecoptera	0.2	2.7	2.4	14.5	0.4	1.9	4.3	1.8
Hemiptera	0.2	0.1	0.3	-	-	-	27.9	30.2
Coleoptera	0.4	0.3	3.1	2.8	0.1	0.5	15.8	30.2
Trichoptera	28.8	23.6	40.2	18.5	76.5	68.8	16.2	10.2
Diptera	20.2	19.8	23.9	22.8	11.2	16.2	19.2	13.8

TABLE 3

RELATIVE DENSITY (%) OF INSECTS IN A STREAM AT BAROG FOR 1989-90 AND 1990-91, AND AT FOUR SITES FOR 1989-91 (BOTH YEARS COMBINED).

Taxon	1989-90	1990-91	1989-91			
			Rocky Site I	Gravel-Rubble Site II	Loose stones Site III	Midstream pools Site IV
Order EPHEMEROPTERA						
Baetis sp.1	13.87	19.25	34.43	16.19	5.00	7.96
Baetis sp.2	0.82	2.17	2.77	1.53	0.50	-
Baetiella tuberculata (Kazlauskas)	1.89	1.09	5.03	0.66	0.70	1.33
Baetiella sp.	1.40	1.50	4.30	0.73	0.82	0.88
Ecdyonurus sp.1	1.44	2.37	0.30	2.78	1.49	0.66
Ecdyonurus sp.2	1.25	1.00	0.13	1.45	1.43	0.22
Epeorus sp.	0.90	1.76	0.94	1.65	0.79	1.99
Ephemerella sp.1	0.84	0.35	0.30	0.88	0.47	0.22
Ephemerella sp.2	0.79	1.20	0.67	1.53	0.32	0.22
Ironopsis sp.	0.25	0.01	0.64	0.03	0.03	-
Choroterpes (*Euthraulus*) sp.	0.39	0.29	0.34	0.41	0.29	0.22
Caenis sp.	3.68	3.50	1.45	6.53	0.23	1.99
Ephemera remensa Eaton	0.05	0.03	-	0.07	0.06	-
Order DIPTERA						
Simulium (*M.*) *ghoomense* Dutta	0.39	0.98	0.34	0.83	0.50	1.33
Simulium (*S.*) sp.	1.02	2.41	1.92	1.97	1.05	0.22
Simulium (*S.*) *digitatum* Puri	0.82	3.04	3.15	1.32	1.41	4.42
Simulium (*N.*) sp.	0.11	0.20	0.16	0.12	0.09	1.11
Simulium (*S.*) *himalayense* Puri	0.51	0.98	0.60	0.74	0.61	1.99
Simulium (*S.*) *rufibasis* Brunetti	0.05	0.11	-	0.10	0.12	-
Pentaneura sp.	3.22	1.89	0.51	4.69	0.76	0.88
Diamesa sp.	1.55	1.78	1.49	1.79	1.38	2.88
Cryptochironomus sp.	2.89	1.78	2.17	2.87	1.76	2.43
Microtendipes sp.	5.11	5.08	8.65	4.55	4.13	1.33
Pseudochironomus sp.	0.81	0.38	0.09	0.81	0.73	0.22
Palpomyia sp.	0.41	0.03	-	0.49	-	0.22
Atrichopogon sp.	0.05	0.01	0.09	0.05	-	-
Forcipomyia sp.	0.01	0.00	-	0.02	-	-
Horaia sp.	0.02	0.00	0.09	-	-	-
Blepharocera indica Brunetti	0.00	0.09	0.04	0.07	-	-
Telmatoscopus livingstoni Ipe & Kishore	0.02	0.00	-	0.02	-	-
Psychoda alternata Say	0.01	0.00	0.04	-	-	-
Pericoma kothiensis Ipe & Kishore	0.01	0.00	-	0.02	-	-
Atherix sp.	0.34	0.85	0.21	1.05	0.03	0.22
Antocha sp.	1.08	0.40	0.21	1.01	0.85	0.22
Holorusia sp.	0.01	0.00	-	0.02	-	-
Hexatoma sp.	0.08	0.00	-	0.10	-	-
Tabanus sp.	0.68	0.14	0.09	0.87	0.03	-
Dixa sp.	0.13	0.03	-	0.10	0.03	0.88
Order TRICHOPTERA						
Agapetus triangularis Martynov	28.27	23.37	19.39	15.67	51.83	3.54
Lepidostomatidae	12.41	3.24	2.85	7.27	13.85	9.51
Rhyacophila sp.	0.19	0.03	0.30	0.10	0.06	-
Chimarra aberrans Martynov	0.17	0.50	0.38	0.25	0.43	0.22

TABLE 3 (*contd.*)
RELATIVE DENSITY (%) OF INSECTS IN A STREAM AT BAROG FOR 1989-90 AND 1990-91, AND AT FOUR SITES FOR 1989-91 (BOTH YEARS COMBINED).

Taxon	1989-90	1990-91	1989-91			
			Rocky Site I	Gravel-Rubble Site II	Loose stones Site III	Mid stream pools Site IV
Stenopsyche sp.	0.14	0.24	-	0.32	0.12	-
Hydroptilidae	0.01	0.03	0.04	-	0.03	-
Polycentropodidae	0.39	0.37	0.13	0.26	0.85	-
Cheumatopsyche columnata Martynov	5.13	6.05	2.98	6.75	5.77	1.33
Order PLECOPTERA						
Nemoura sp.	1.10	6.55	1.11	6.05	0.88	2.88
Amphinemura rahungi Aubert	0.05	1.37	0.09	1.25	0.05	-
Neoperla sp.1	0.38	0.18	0.64	0.26	0.09	0.67
Neoperla sp.2	0.22	0.18	0.47	0.19	0.09	-
Order COLEOPTERA						
Elmidae	1.31	0.55	0.13	1.86	0.12	0.45
Orectochilus murinus Regimbart	1.03	1.29	0.04	0.85	0.15	18.58
Dineutus (*P.*) *indicus*	0.01	0.00	-	-	-	0.22
Psephanoides gahani Champion	0.04	0.25	0.17	0.20	0.03	-
Order HEMIPTERA						
Chimarrhometra orientalis (Distant)	1.12	0.33	-	0.02	-	20.58
Onychotrechus robustus Anderson	0.00	0.01	-	-	-	0.22
Metrocoris compar (Buchnan White)	0.26	0.25	0.13	0.03	-	5.98
Enithares sp.	0.00	0.01	-	-	-	0.22
Micronecta sp.	0.19	0.01	-	0.07	-	1.56
Order ODONATA						
Baydera indica (Selys)	0.01	0.03	-	0.02	0.03	-
Gomphidae	0.32	0.14	-	0.51	-	-
Order MEGALOPTERA						
Corydalus sp.	0.01	0.01	-	0.02	-	-
Total number of taxa	59	54	44	56	44	38

present in significant numbers on rocky substratum, while *Caenis* sp. was frequent in gravel-rubble. *Ecdyonurus* spp. were generally associated with gravel-rubble and loose stones.

The distribution and abundance of chironomids varied greatly between the sites: *Microtendipes* sp. and *Cryptochironomus* sp. were abundant on rocky and gravel-rubble substrate, and among loose stones, while *Pentaneura* sp. was numerous in gravel-rubble. The simulid, *Simulium* (*S.*) *digitatum* attained abundance on rocky substratum in midstream pools. Families Blepharoceridae (*Horaia* sp.; *Blepharocera indica*), Psychodidae (*Telmatoscopus livingstoni*; *Psychoda alternata*; *Pericoma kothiensis*) and Tipulidae (*Holorusia* sp. and *Hexatoma* sp.) were

largely confined to rocky substratum or gravel-rubble section of the riffle.

Among Trichoptera, *Agapetus triangularis* (51.83%) and *Cheumatopsyche columnata* (6.75%) were abundant on loose stones with significant numbers on rocky substratum and in gravel-rubble. Likewise, the representatives of Lepidostomatidae (13.85%, 7.27%) predominated among loose stones and in gravel-rubble, but also with significant numbers in midstream pools. *Chimarra aberrans* were collected from all 4 sites, although at low densities. *Rhyacophila* sp. and members of Poly-centropodidae were not found in midstream pools.

Among other insect groups, the stonefly *Nemoura* sp. was more abundant in gravel-rubble than in other sites. The gyrinid beetles (*Orectochilus murinus*) and the gerrid Hemiptera (*Chimarrhometra orientalis*; *Metrocoris compar*) preferred midstream pools.

Species diversity index

Species diversity indices (H') for different months are depicted in Table 4. Quantification of species diversity index indicated generally higher values from summer to autumn (May to October). Lower values were recorded in late winter and spring months (January to April) during the first year, and in November, December and March during the second year. A peak diversity index of 2.55 occurred in October and 2.77 in May during the first and second years respectively. Minimum diversity index of 1.43 was obtained for April, 1990, and it was 1.76 for March, 1991. The mean monthly species diversity indices varied little between two years i.e. 2.13 and 2.66 during the first and second years, respectively.

Table 4
INDICES OF SPECIES DIVERSITY (H') OF INSECTS DURING DIFFERENT MONTHS IN A STREAM AT BAROG (H.P.) 1989-1991 (BOTH YEARS COMBINED)

Month	Index of species diversity (H')	
	1989-90	1990-91
Jun.	2.30	2.30
Jul.	N.R.	2.62
Aug.	2.40	2.30
Sep.	2.37	2.45
Oct.	2.55	2.18
Nov.	2.39	1.90
Dec.	2.10	2.38
Jan.	1.91	1.91
Feb.	1.81	2.19
Mar.	1.93	1.76
Apr.	1.43	2.34
May	2.25	2.77
Mean annual	2.13	2.26

N.R. = Not recorded

Discussion

From the available data, the stream under study can be described as an Ephemeroptera-Trichoptera-Diptera type. This type of aquatic insect community, also represented by Plecoptera and Coleoptera, appears to be characteristic of streams with gravel and rubble in both tropical and temperate regions (Bishop 1973; Minshall and Kuehne 1969; Clifford 1978; Gupta and Michael 1983).

Certain species indicated a preference for microhabitats within a short span of the stream. Substrate type influenced their distribution the most, which is consistent with the observation of Arunachalam *et al.* (1991) on the invertebrates of a south Indian river. Nymphs of the mayflies *Baetiella tuberculata* and *Baetiella* sp. (Family Baetidae) were abundant at Site I with rocky substrate and rapid water current, while the dipteran larvae of *Horaia* sp. (Family Blepharoceridae) were restricted in occurrence. They displayed obvious morphological modifications for adaptation to rocky substrate to withstand the force of rapid currents. The abundance of *Baetiella* sp. at this site may be attributed to their streamlined bodies and sparsely fringed cerci, which provide the least resistance to the rapid water current. In addition, their claws

are dentate for clinging to rocky surfaces. Their food includes algae growing on submerged rocky substrate which is available in plenty at this site. The preference of *Baetiella* for rocky substrate with a fast current has also been demonstrated by Dudgeon (1990) in Hongkong streams. To withstand the force of water current, larvae of *Horaia* sp. are provided with 6 median ventral suction discs which function efficiently only on rocky surfaces.

Site II of the stream is a mixed substrate section comprising gravel, rubble, coarse sand particles and silt. It provides many microhabitats and therefore supports a greater variety of taxa (56 species; Table 3).

Immature stages of several benthos had also higher densities in gravel-rubble section than in other microhabitats e.g. *Ecdyonurus* sp.1, *Epeorus* sp., *Ephemerella* spp. and *Caenis* sp. among mayflies; *Nemoura* sp. and *Amphinemura rahungi* among stoneflies; elmid beetles; *Pentaneura* sp. and *Palpomyia* sp. among dipterans. Nymphs of *Caenis* are adapted to burrowing in coarse particles, sand and silt, and possess a large second pair of gills which are operculate and protect succeeding gills from becoming clogged with silt. Their abundance in gravel-rubble is due to their adaptation to live in silt and coarse sand particles deposited between gravel and rubble, which also provides them a sheltered microhabitat. Cummins and Lauff (1969) also found that light silting enhanced the selection of interstices of coarse sediments by *Caenis latipennis*. However, Bishop (1973) suggested that microdistribution of *Caenis* sp. was due to food availability and habitat stability rather than a particular substrate. Like *Caenis* sp., nymphs of *Nemoura* sp. and *Amphinemura rahungi* also burrow in coarse particles among gravel-rubble, for protection from predators.

The nymphs of *Ecdyonurus* sp.1, *Epeorus* sp. and *Ephemerella* spp. have flat bodies which appear to be an adaptation to decrease resistance to water current, and also to enable them to seek shelter in crevices and under stones. High density of dorsoventrally flattened nymphs of the mayfly *Habrophlebia vibrans* has also been correlated with the presence of gravel in a Canadian stream (Lauzon and Harper 1988). The bodies of the elmid beetle larvae and the chironomid *Pentaneura* sp. are long, slender and flexible, and allow easy passage among gravel and rubble. They seek out this type of microhabitat as a refuge, and also to exploit micronutrients trapped among substrate particles (Williams and Feltmate 1992).

The case-building caddisfly larvae of *Agapetus triangularis* of the family Glossosomatidae and representatives of the family Lepidostomatidae were predominant among loose stones in the gravel-rubble zone. Their abundance is possibly due to the presence of mineral and organic matter required for case building, and also protection against water current. In the rocky zone, they were lower in number because of fast water current (i.e. mean 0.71 m s^{-1} against mean 0.46 m s^{-1} in gravel-rubble section), and less amount of mineral and organic matter. A few workers have also related the abundance of case-building caddisfly larvae with the availability of material for their case construction. According to Tolkamp (1980) *Sericostoma personatum* uses mainly 0.25-0.50 mm grains of minerals for its case, and it prefers to live on predominantly coarse substrate. Similarly, the larvae of *Pycnopsyche scabripennis* prefer substrates where suitable materials for their cases are present (Mackay 1977). Net spinning larvae of the trichopteran *Cheumatopsyche columnata* were more common in the gravel-rubble zone than at other sites. Possibly, this microhabitat provided suitable substrate to attach their nets for trapping food particles flowing with slow water current. Larvae of some *Simulium* spp., well known filter feeders, were also more abundant in the gravel-rubble zone than elsewhere, because of the availability of suitable substrates (stones) for their attachment and a rich supply of FPOM (mean 15.375 mg m^{-2}).

Chimarrhometra orientalis, *Onychotrechus robustus* and *Metrocoris compar* (Gerridae: Hemiptera) and *Orectochilus murinus* (Gyrinidae: Coleoptera) showed preference for midstream pools usually formed by the side of bigger rocks. They are able to avoid the force of water current in this microhabitat. Similarly, Williams and Feltmate (1992) found these in abundance in such a habitat where the water current was of less intensity. However, the young stages of Gerridae and Gyrinidae occupied different ecological zones, the former midstream pools and the latter gravel section.

Seasonal changes in species diversity were evident during both years. Low values of diversity indices (H') occurred in late winter and spring during the first year. Unfavourable climatic conditions probably caused depressed winter values. Rosillon (1985) also recorded lower winter values in a Belgian chalk trout stream, but with less evident seasonal changes in species diversity. In Barog stream, mean annual species diversity indices of 2.13 and 2.26, during the first and second years respectively, were slightly lower than 2.44 as recorded by Rosillon (1985). However, Burton and Sivaramakrishnan (1993) reported higher values of species diversity (H'), ranging from 3.86 to 4.41, in a wet evergreen forest stream of the Silent Valley National Park, southern India.

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■ ■ ■

ON A COLLECTION OF FISHES FROM THE SOUTHERN PART OF UKHRUL DISTRICT, MANIPUR[1]

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Key words: Fish, Ukhrul district, Manipur

The southern part of Ukhrul district is drained by three important rivers, viz., Chatrickong, Maklang and Litan. The rivers form a part of the Chindwin river system. A detailed survey of the fish fauna shows 69 species belonging to 45 genera, 18 families and 7 orders. The collections include new records of 6 species, viz., *Schistura multifasciatus* (Day), *Psilorhyncus balitora* (Ham.), *Labeo fimbriatus* (Bloch), *Tetraodon cutcutia* (Ham.), *Puntius puntio* (Ham.), and *Macrognathus panculas* (Ham.) from Manipur. *Tor putitora* (Ham.) and *Pseudocheneis sulcutas* (Hora) are new records from the Chindwin drainage and *Mystus pulcher* (Chaudhuri) and *Exostoma stuarti* (Hora) are new records from India.

Introduction

The fish fauna of Ukhrul dist. has not been studied in detail. The district is situated at the extreme eastern part of Manipur State. It shares about 200 km of international border with Myanmar in the east. It is bounded by Nagaland on the north, Senapati in the west and Chandel in the south. Three major rivers drain the southern part of Ukhrul from west to east, which are the waterheads of the Chindwin drainage. Chatrickong is formed by the confluence of Sanalok and Khunukong. Khunukong originates in the foothills of Shiroi hills, while Sanalok originates in the foothills of Khayangphung hill. Sanalok flows near the boundary to the south for about 100 km, meets Khunukong at Dha-ado, and flows as Chatrickong to the east into the Chindwin of Myanmar. The Maklang river originates near Khangkhui. It is joined by the Tuyungbi and flows for about 90 km to meet the Yu river a branch of the Chindwin in Myanmar. Litan river originates in the western foothills of the Shiroi. It follows a southwesterly course to meet Imphal river, which flows out of India as River Manipur, to meet the Chindwin. Although there are some reports on the fishes of Manipur (Chaudhuri 1912, Hora 1921, Hora and Mukherji 1935, Hora 1936, Menon 1952, Menon 1954), a detailed survey of the fishes of southern Ukhrul dist. has not been carried out. This paper reports on the fishes of three major rivers of southern Ukhrul dist.

Material and Methods

An extensive collection of fishes was made from Chatrickong, Maklang and Litan between March, 1995 and May, 1997. The specimens were collected by cast net, gill net, sidetracking, and chemical bait. Fishes were identified as per Jayaram (1981). The specimens were compared with collections at Manipur University Museum of Fisheries (MUMF) and Zoological Survey of India (ZSI) to confirm their identification.

Observations and Discussion

68 species belonging to 45 genera, 18 families and 7 orders were collected. It has been recorded that the fish fauna of southern Ukhrul dist. has Myanmarese as well as endemic elements and also some widely distributed species. *Nemacheilus manipurensis* Chaudhuri, *N. prasadi* Hora, *Garra litanensis* Vishwanath, *Semiplotus manipurensis* Vishwanath, *Glyptothorax sinense manipurensis* (Menon) are endemic to the hill streams of Manipur. The Myanmarese elements are *Raiamas guttatus*

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LIST OF FISHES WITH LOCAL NAMES, THEIR DISTRIBUTION AND OCCURRENCE

Scientific name	Local name	Distribution			Remarks
	Tangkhul/Manipuri	Chatrickong	Maklang	Litan	
(1)	(2)	(3)	(4)	(5)	(6)
ANGUILLIFORMES					
Anguillidae					
1. *Anguilla bengalensis* (Gray)	Manoi/Ngaril Laina	+	-	-	x
CYPRINIFORMES					
Cyprinidae					
2. *Crossocheilus burmanicus* (Hora)	Ungri/Ngaroi	+	+	+	x
3. *Chagunius nicholsi* (Myers)	Khisei/Ngara	+	+	-	x
4. *Cirrhinus reba* (Ham.)	Adhue/	+	+	-	x
5. *Semiplotus manipurensis* Vish. & Kosygin	Aveah/Ngakoi	+	+	-	x
6. *Labeo dero* (Ham.)	Adhue/Ngaton	-	+	-	x
7. *Labeo calbasu* (Ham.)	do/Ngathi	+	-	-	x
8. *Labeo pangusia*	do-	+	-	-	x
9. *Labeo fimbriatus* (Bloch)	do-	+	-	-	RM
10. *Neolissochilus stracheyi* (Day)	Khaicham/Ngara	+	-	-	x
11. *N. hexagonolepis* (McClelland)	Khaicham/Ngara	-	+	-	x
12. *Osteobrama cotio* (Ham.)	Khiboi/Ngaseksha	+	-	-	x
13. *Puntius ticto* (Ham.)	Khaiwonla/Ngakha	+	-	+	x
14. *Puntius puntio* (Ham.)	do-	+	-	-	RM
15. *Puntius saphore* (Ham.)	do-	+	-	-	x
16. *Puntius clavatus burtoni* Mukherji	Khaiseng/Heikaknga	+	+	+	x
17. *Raiamas guttatus* (Day)	Ngawapyiva/Ngawathonkgong	+	+	+	x
18. *Barilius barila* (Ham.)	Maseova/Ngawa	+	-	-	x
19. *Barilius* sp. 1	Maseova/Ngawa	+	-	-	x
20. *Barilius barna* (Day)	Maseova/Ngawa	+	-	+	x
21. *Barilius* sp. 2	Maseova/Ngawa	-	-	+	x
22. *Tor tor* (Ham.)	Khihue/Ngara	+	+	-	x
23. *Tor putitora* (Ham.)	Khihue/Ngara	+	-	-	RC
24. *Danio aequipinnatus* (McClelland)	Khipuli/Nunga	+	+	+	x
25. *Chela fasciatus* (Silas)	Khinge/-	+	-	-	x
26. *Salmostoma sladoni* (Day)	Khivi/-	+	-	-	x
27. *Amblypharyngodon mola* (Ham.)	Khaiwonla/Mukaknga	+	-	+	x
28. *Aspidoparia morar* (Ham.)	Khaitam/-	+	-	-	x
29. *Esomus danricus* (Ham.)	Khira/Ngashang	+	-	-	x
30. *Rasbora rasbora* (Ham.)	Khira/-	1	-	-	x
31. *Garra nasuta* (McClelland)	Ngi-ung/Ngamushangum	+	+	+	x
32. *Garra lissorhyncus* (McClelland)	Ngi-ung/Ngamushnangum	+	+	-	x
33. *Garra manipurensis* Vish. & Saroj.	Ngi-ung/Ngamusangum	-	-	+	x
34. *Schizothorax richardsonii* (Gray)	Khainguila/Sananga	+	+	-	x

LIST OF FISHES WITH LOCAL NAMES, THEIR DISTRIBUTION AND OCCURRENCE (**contd.**)

Scientific name	Local name	Distribution			Remarks
	Tangkhul/Manipuri	Chatrickong	Maklang	Litan	
(1)	(2)	(3)	(4)	(5)	(6)
Psilorhynchidae					
35. *Psilorhynchus balitora*	Chanrila/Nunga	-	+	-	RM
36. *Psilorhyncus homaloptera* (Hora)	Chanrila/Nunga	+	-	-	x
Balitoridae					
37. *Balitora brucei* (Gray)	Lungvap/-	+	+	-	x
38. *Schistura manipurensis* Chaudhuri	Hangkorkhai/Ngatup	+	1	-	x
39. *S. vinciguera* (Hora)	Hangkorkhai/Ngatup	+	+	+	x
40. *S. prashadi* Hora	Hangkorkhai/Ngatup	+	+	-	x
41. *S. multifasciatus* (Day)	Hangkorkhai/Ngatup	+	-	-	RM
42. *S. kangjupkhulensis* Hora	Hangkorkhai/Ngatup	-	+	-	x
Cobitidae					
43. *Pangio pangia* (Ham.)	Khi-ngi/Nganap	-	+	-	x
44. *Botia berdmorei* (Blyth)	Khikhana/Sarengkhoibi	+	+	+	x
45. *Botia histrionica* (Blyth)	Khikhana/Serengkhoibi	+	+	-	x
Siluriformes: Siluridae					
46. *Ompok bimaculatus* (Bloch)	Khitu/Ngaten	+	-	-	x
Bagridae					
47. *Batasio tengana* (Ham.)	Khitheo/Ngarang	-	+	-	x
48. *Mystus bleekeri* (Day)	Khithea/Ngasep	+	-	+	x
49. *Mystus pulcher* (Chaudhuri)	Khithea/Ngasep	+	-	-	RI
50. *Mystus cavasius* (Ham.)	Khithea/Ngasep	+	-	-	RM
Amblycepitidae					
51. *Amblyceps mangois* (Ham.)	Khiva-kwah/-	+	+	-	x
Sisoridae					
52. *Bagarius bagarius* (Ham.)	Khaimi/Ngarel	+	+	-	x
53. *Erethestes pussilus* (Müller)	Lungthei/-	-	1	-	x
54. *Exostoma stuarti* (Hora)	Lungthei/-	+	-	-	RI
55. *Glyptothorax platigoponoides* (Bleeker)	Kapangh/Ngapang	+	+	-	x
56. *G. tritineatus* (Blyth)	Kapangh/Ngapang	+	+	-	x
57. *G. sinense manipurensis* (Regan)	Kapangh/Ngapang	-	+	-	x
58. *Pseudocheneis sulcatus* (McClelland)	Khikha/-	+	-	-	RC
Cyprinodontiformes: Belonidae					
59. *Xenentodon cancila* (Ham.)	Morsangkhai/Ngacheklaobi	-	+	-	x

LIST OF FISHES WITH LOCAL NAMES, THEIR DISTRIBUTION AND OCCURRENCE (**contd.**)

Scientific name	Local name	Distribution			Remarks
	Tangkhul/Manipuri	Chatrickong	Maklang	Litan	
(1)	(2)	(3)	(4)	(5)	(6)
Perciformes: Ambassidae					
60. *Chanda nama* (Ham.)	Khihungsha/Ngamhai	+	-	-	x
Nandidae					
61. *Nandus nandus* (Ham.)	Ngwa-ngae/-	+	-	-	x
62. *Badis badis* (Ham.)	Ngwa-masha/-	+	-	-	x
Gobiidae					
63. *Glossogobius giuris* (Ham.)	Khaivachar/Nailonnga	+	-	+	x
Anabantidae					
64. *Anabas testudineus* (Bloch)	Tampakhai/Ukabi	+	-	-	x
Belotiidae					
65. *Colisa fasciatus* (Schneider)	Khaishim/Ngabema	+	-	-	x
Channidae					
66. *Channa gachua* (Ham.)	Khaiva/Meiteingamu	+	+	+	x
Tetradontiformes: Tetradontidae					
67. *Tetraodon cutcutia* (Ham.)	Khikaro/Hangoinga	-	+	-	RM
Mastacembeliformes: Mastacembelidae					
68. *Macrognathus pancalus* (Ham.)	Khiphue/Ngarin	+	-	-	RM
69. *Mastacembelus armatus* (Lecepede)	Khiphue/Ngarin	+	+	+	x

RM = new records from Manipur, RI = new records from India, RC = records from Chindwin drainage, - = absent, + = present,

(Day), *Osteobrama cotio cunma* (Day), *Crossocheilus burmanicus* Hora, *Garra gravelyi* (Annandale), *Neolissochilus stracheyi* (Day), *Chagunius nicholsi* (Myers), *Salmostoma sladoni* (Day) and *Mystus pulcher* (Chaudhuri). The remaining fishes are widely distributed and common in other parts of India.

Taxonomic Remarks

■ ***Schistura multifasciatus*** (Day, 1878). *Fish. India,* p 617 (Type locality: Darjeeling and Assam)

Material examined: 1 ex., Chatrickong river, 2-ii-1997, SL 41.3 mm

Distribution: INDIA: Chatrickong River and NEPAL

Remarks: New record from Manipur. Body marked by 16 vertical bands and a black spot at base of anterior dorsal fin rays.

■ ***Psilorhyncus balitora*** (Ham. 1822). *Fishes of Ganges,* p 393. (Type locality: Rivers of northeast Bengal).

Material examined: 11 ex. Maklang river, 24-iv-1995 SL 39.5-61.3 mm

Distribution: INDIA: Chatrickong river, BANGLADESH, NEPAL and MYANMAR

Remarks: New record from Manipur. Lateral scales 30-34, branched dorsal fin rays 8

8, head small and conical.

■ ***Labeo fimbriatus*** (Bloch, 1795). *Natugesog. auland. fische,* 12: 50, pl 409. (Type locality: "Malabarischen Kueste", Madras)

Material examined: 1 ex. Chatrickong river, 6-vi-1996. SL 88.6 mm

Distribution: INDIA: Chatrickong river, NEPAL and MYANMAR.

Remarks: New record from Manipur. Dorsal fin with 15 branched rays and lateral transverse scale row 5 between lateral line and pelvic fin base.

■ ***Tetraodon cutcutia*** (Hamilton, 1822). Fishes of Ganges, 8, 362, pl. 18 fig. 3 (Type locality: Ganges river)

Materials examined: 2 ex. Maklang river, 24-iv-1995. SL 130.5-131 mm

Distribution: INDIA: Maklang river, BANGLADESH, SRI LANKA, MYANMAR and MALAY ARCHIPELAGO.

Remarks: New record from Manipur. Dorsal fin with 10-12 rays, anal fin with 10 rays. Only two species found in Indian rivers.

■ ***Puntius puntio*** (Hamilton, 1822). *Fishes of Ganges,* pl 318, (Type locality: Ponds and ditches of southern Bengal)

Material examined: 1 ex. Chatrickong river, 6-vi-1996. TL 22.5 mm

Distribution: INDIA: Chatrickong river, BANGLADESH and MYANMAR.

Remarks: New record from India. A single wide band around the base of caudal fin.

■ ***Pseudocheneis sulcatus*** (McClelland, 1842). *J. nat. Hist. 2*: 587. (Type locality: Khasi Hills, Meghalaya)

Materials examined: 1 ex. Chatrickong river, 12.v.1997. SL 125.3 mm.

Distribution: INDIA: Chatrickong, NEPAL and BANGLADESH.

Remarks: New record from Chindwin drainage. The species is characterised by broad and oval thoracic apparatus and four large irregular reddish-brown blotches on side of lateral line.

■ ***Macrognathus panculas*** (Ham. 1822). *Fishes of Ganges.* 30,364. (Type locality: Tanks of Ganges province)

Material examined: 5 ex. Chatrickong river, 6.vi.1996 SL 74.4-85.6 mm

Distribution: INDIA: Chatrickong river, PAKISTAN and BANGLADESH.

Remarks: New records from Manipur. Dorsal spine with 24-25 and with many yellowish-white spots on the flank on the sides of the body.

■ ***Tor putitora*** (Ham. 1822). *Fishes of Ganges.* 303: 388. (Type locality: Eastern part of Bengal)

Material examined: 3 ex. Chatrickong river. 2.ii.1997 SL 133.4.166.2 mm

Distribution: INDIA: Chatrickong river, AFGHANISTAN, PAKISTAN, NEPAL and BANGLADESH.

Remarks: New record from Chindwin drainage. The species can be easily distinguished from *Tor putitora* from its greater snout length. Since it is one of the waterheads of Chindwin drainage the species might also occur in Myanmar.

■ ***Mystus pulcher*** (Chaudhuri, 1911). *Rec. Indian, Mus.* 6:20. (Type locality: Bhamo, Myanmar)

Materials examined: 6 exs. Chatrickong river. 6-6-96. SL 65.3-69.8 mm

Distribution: INDIA: Chatrickong river and MYAN MAR

Remarks: New record from India. The species can be easily differentiated from other species by the presence of two large black spots, one on the dorsal fin base and the other on the caudal fin base. The species was listed by Dutta and Laisharam (1984) in their zoogeographic study on the fishes of Manipur; however, it was not present in their collection. Thus it is a new records from India.

■ ***Exostoma stuarti*** (Hora, 1923). *Rec. Indian. Mus., 25*, p. 39. (Type locality: Namyak river at Tanga in the northern frontier of Myanmar).

Materials examined: 1 ex. Chatrickong river, 12.v.1997, SL 68 mm

Distribution: INDIA: Chatrickong and

MYANMAR: Namyak river at Tanga.

Remarks: New record from India. Adiposed dorsal fin free from caudal fin; a distinct black spot at the base of the pectoral fin; least height of caudal peduncle 2.02 in its length. The species is known to occur only in Myanmar but this report now extends its distribution to India.

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MORTALITY AND SURVIVAL OF THE HIMALAYAN MAHSEER *TOR PUTITORA* IN A REGULATED SECTION OF THE RIVER GANGA BETWEEN RISHIKESH AND HARIDWAR[1]

J.P. BHATT AND P. NAUTIYAL[2]

Key words: Himalayan Mahseer, *Tor putitora,* mortality rate, survival rate, river Ganga

Studies were conducted to assess the mortality and survival rates of the Himalayan Mahseer *Tor putitora* in the foothills section of the Ganga 285-290 m above msl (29° 56' N lat., 78° 10' E long.), where the river has been extensively regulated through two barrages and an array of canals for hydropower generation, irrigation and recreation. The mortality and survival rates of samples measuring 14.5 to 98 cm in length were observed to be 0.414 and 0.586 (pooled sample), 0.348 and 0.652 (1993-94), 0.487 and 0.513 (1994-95), 0.499 and 0.501 (male) and 0.381 and 0.619 (female) respectively, in the 1+ to 9+ age-group fishes. The weighted mortality and survival rates were 0.323 and 0.67 (pooled sample), 0.346 and 0.654 (1993-94), 0.47 and 0.53 (1994-95), 0.436 and 0.564 (males) and 0.467 and 0.567 (females) respectively, while instantaneous mortality rate was 0.589, 0.53, 0.693, 0.855 and 0.555 in the pooled sample, 1993-94, 1994-95, males and females respectively. Mortality was high in the higher age groups in captivity.

INTRODUCTION

The age composition of the stock, the relative strength of different age groups and the maximum life span are, within certain limits, species characteristic. Fishes with short life cycle, with a population which consists of only a few age groups, are adapted to living under conditions of very high and variable mortality. On the other hand, species which form populations containing many age groups and with late mortality are adapted to living under conditions of a relatively stable food supply, negligible annual fluctuation in the mortality of mature individuals, and little effect of predator fishes. If a substantial part of a population should die, its replacement is slow and this is reflected in the age composition which is a function of replacement, growth and death (Nikolsky 1976).

Smith (1983) and Wankowski *et al.* (1988) studied the mortality rates in *Nemadactylus macropterus*, but information on the mortality of *T. putitora* is not available in India and in Garhwal region.

MATERIAL AND METHODS

Fishing mortality rates were estimated from commercial landings from the foothills section of the Ganga near Ajeetpur, a riverside village located downstream of Haridwar. The fish samples were taken randomly from the fish contractor at Ajeetpur or from the Raiwala fish market (where fish is supplied from Ajeetpur). Fish samples were given an abdominal incision and preserved in 10% formalin. In the case of large fishes, length and weight was recorded on the spot and scales were collected.

The age of the samples was determined with the help of key scales (Bagenal 1978) obtained from the base of dorsal and pectoral fins from fishes measuring 14.5 to 98 cm. Preliminary screening indicated that the number of rings was similar in the dorsal and pectoral scales. Thus only dorsal fin region scales were selected. To determine the age, the scales were analysed with a Carl Zeiss Jena Documeter. The number of

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annuli in each key scale was recorded. Annulus formation was determined by the criteria suggested by Bagenal (1978) and adopted by Nautiyal (1990). According to him, a zone of closely spaced ridges is followed by a zone of widely spaced ridges. The annulus is usually considered to be at the outer border of the closely spaced ridges.

The mortality and survival rates were determined by the age frequency method (Rounseefell and Everhart 1985), using the following equations.

The annual mortality rate (r) = (1-s) or (1-e δ) where *s* (rate of survival) was computed in the following manner:

$$\log s = \frac{\left[\sum_{y=x}^{n-1} \log f(y)\right] - \left[\sum_{y=x-1}^{n} \log f(y)\right]}{n}$$

where f(y) = age frequency at any age (y)

The instantaneous mortality rate (δ) was computed as follows:

$$\delta = \log_{10}(1/s)\,(1/\log_{10e}) = \log_e(1/1\text{-}r)$$
where $1/\log_{10e} = 2.303$

Observations

The rates obtained for the year-class samples 1993-94 and 1994-95 were 0.348 and 0.487 respectively. The mortality rate for the pooled data (1993-1995) was 0.414 (Table 1). The survival rate for the pooled data was recorded as 0.586. Relatively higher survival rate was recorded in the 1993-94 year sample (0.652) as compared with 1994-95 year sample (0.513). The weighted mortality rate was found to be 0.346, 0.47 and 0.323 for the 1993-94, 1994-95 and pooled year samples, respectively. The weighted survival rates were 0.65, 0.53 and 0.67 for 1993-94, 1994-95 and pooled samples (Table 1).

Mortality rate was observed to be 0.499 for males and 0.381 for females. The survival rates were recorded as 0.501 and 0.619 in male and female, respectively. Weighted mortality rates were found to be 0.436 and 0.467, while survival rates were 0.564 and 0.567 in male and female respectively. The instantaneous mortality rate was 0.855 in male and 0.555 in female (Table 1).

The 1+ and 2+ age groups showed zero mortality rates in the year class sample 1993-94, male and female. Zero mortality was also observed in the 3+ age group during 1994-95. Low mortality and higher survival rates were observed in the lower age classes (3+, 4+) while higher mortality and lower survival rates were seen in the higher age groups (8+, 9+; Table 2).

Discussion

Studies indicate that information on the various aspects of population structure is important for managing natural populations, especially commercially exploited fish stock. The age structure, like other parameters of the population, may change from time to time,

Table 1

COMPUTATION OF MORTALITY AND SURVIVAL RATES IN *TOR PUTITORA* FOR DIFFERENT YEARS AND SEXES

Parameters	1st year (1993-94)	2nd year (1994-95)	Pooled samples	Male	Female
Instantaneous mortality rate	0.530	0.693	0.589	0.855	0.555
Mortality rate	0.348	0.487	0.414	0.499	0.381
Survival rate	0.652	0.513	0.586	0.501	0.619
Weighted mortality rate	0.346	0.470	0.323	0.436	0.467
Weighted survival rate	0.654	0.530	0.677	0.564	0.567

TABLE 2

COMPUTATION OF MORTALITY AND SURVIVAL RATES OF *TOR PUTITORA* IN THE POOLED SAMPLES

A	B	C	D	E	F	G	H
Age (y)	Freq. (f)	log f	log f (y) -f (y-1)	D times (2.303)	(1-D)	Antilog (DX√f)	weighted by f(y)
1	14	1.146					
2	62	1.792					
3	58	1.763	-0.029	0.066	0.971	0.935	-0.220
4	43	1.633	-0.130	0.299	0.870	0.741	-0.851
5	20	1.301	-0.332	0.764	0.668	0.465	-1.484
6	11	1.041	-0.260	0.598	0.74	0.549	-0.860
7	8	0.903	-0.138	0.317	0.862	0.727	-0.389
8	3	0.447	-0.456	1.050	0.544	0.349	-0.642
9	1	000	-0.447	1.029	0.533	0.341	000
Total	223		1.792	4.123	5.188	4.107	4.446/26.1
(Mean)			(0.256)	(0.589)	(0.741)	(0.586)	=0.169

Instantaneous mortality rate (δ) = 0.589
Mortality rate (r) = 0.414
Survival rate (s) = 0.586

Weighted survival rate/ s(w) = 0.677
Weighted mortality rate r (w) = 0.323
1-0. 169 = 0.831

adapting to change in the environmental conditions. The data on age structure can also be used to draw inferences on the health of the population, its mortality and survival rates (Nikolsky 1976, Bagenal 1978 and Rounseefell and Everhart 1985).

In our study, survival rates were found to be higher than the mortality rates. Relatively higher annual mortality and lower survival rates were found in males (0.499, 0.501) than in females (0.381, 0.619). In the Atlantic salmon also, this difference has been reported by Nikolsky (1980). He also stated that each species has a definite mortality rate. A species with a short life cycle exhibits a relatively higher death rate than one with a long cycle and late maturity such as the Himalayan mahseer.

We reiterate that the numbers of a species before the harvestable size are not a true index for the calculation of mortality/survival rates because the fish at this size/age are vulnerable to fishing gear. Similar results (high mortality in higher age classes and low mortality in the lower age classes) were also obtained by Tandon and Johal (1996) in *C. mirigala* and *L. rohita* from Gobindsagar, and by Graham (1956) in cod and haddock. According to Gulland (1978), the mortality varies continuously with age. It is usually more convenient and more reliable, within an acceptable approximation, to consider that fishing mortality changes abruptly, being zero on the pre-recruits below a certain age and constant from a given age upwards.

It was concluded that mortality in captivity increased with age. Tandon and Johal (1996) stated that increase in mortality between particular age classes is due to substantial increase in the exploitation rate. According to Ricker (1962) and Gulland (1975), the variations in the percentage mortality between different age classes are due to the available stock, shifting of year class, and probably also due to sampling error. Rounseefell and Everhart (1985) stated that weighted values do not depart far from the values computed by the conventional methods, although it may be an advantage to weight when the samples are small.

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BIOSYSTEMATIC STUDIES OF INDIAN CHIRONOMIDAE (DIPTERA)[1]

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(*With three text-figures*)

Key words: Biosystematics, Chironomidae, India.

The taxonomy of Indian Chironomidae attracted attention in the beginning of this century, but their biosystematics still requires attention by Indian dipterologists. The present study highlights some significant factors that require special attention in India, viz. (i) role of Chironomidae in determining water quality and typology of lakes (ii) demography, population dynamics and distribution, (iii) chironomid behaviour and (iv) phylogenetic relationship.

INTRODUCTION

The Chironomidae, a family of amphibiotic insects, have been recognized as bioindicators of water quality. Perhaps no other freshwater amphibiotic insects are more ubiquitous, inhabiting almost all the ecological niches from high altitude glacial torrents to deep eutrophic lakes and seas. The larvae (bloodworms) of some Chironomidae form an important constituent of the biological filter fauna in settling tanks and filter beds in urban water works.

Chironomid species and population composition and its temporal changes reflect sediment quality. They also play an important role in the circulation and energy flow of aquatic ecosystems. Investigations on the role of detritus-feeding benthic chironomid groups enables better understanding of natural purification and oligotrophication of water bodies. Since numerous fish species, such as ruff, carp and eel, feed on chironomid larvae, these investigations can help in fishery development in India.

SYSTEMATICS

The major work in India came from Kieffer (1910-1914), who studied the Chironomidae in the Indian Museum, Calcutta, based mainly on colour patterns and relative sizes of the body parts, particularly of the females. Edwards (1969), Tokunaga (1959), Singh (1958), Singh and Kulshrestha (1975 and 1977), Singh and Maheshwari (1986-1989), Kaul (1970), Chaudhuri and Ghosh (1981, 1982) Chaudhuri and Sinharay (1983) and Maheshwari (1986-1990) contributed to literature on Indian Chironomid fauna. Singh (1958) recorded for the first time high altitude Chironomidae above the timber-line in the Northwest Himalaya. His record of the genus *Brillia* Kieffer remains the solitary example of this Holarctic genus from India. Kaul (1970) described two species of the torrenticole Diamesinae from the same region. Singh and Kulshrestha (1977) described some Chironomidae of the Indogangetic plains. Chaudhuri and Ghosh (1981, 1982) described a new genus *Neopodonomus* from Bhutan, and some Orthocladiinae and Chironomini from eastern India. Chaudhuri and Sinharay (1983) added three new species of genus *Rheocricotopus* Thien. and Harnisch to the Indian fauna from Darjeeling and Shillong. Singh and Maheshwari (1987-89) described the Chironomidae of Chandertal Lake (4270 m above msl), Lahaul Spiti Valley, Northwest Himalaya, with five new species of *Micropsectra* and three new species of *Corynoneura* Winn. Maheshwari (1986-95) described the Chironomidae from Gangetic plain, coastal parts and high altitude regions. He also made a faunal assessment of settling tanks of

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the Civil Water Supply System, Agra, India. Maheshwari and Agarwal (1993) studied the *Harnischia* complex from India.

FAUNAL COMPOSITION OF INDIAN CHIRONOMIDAE

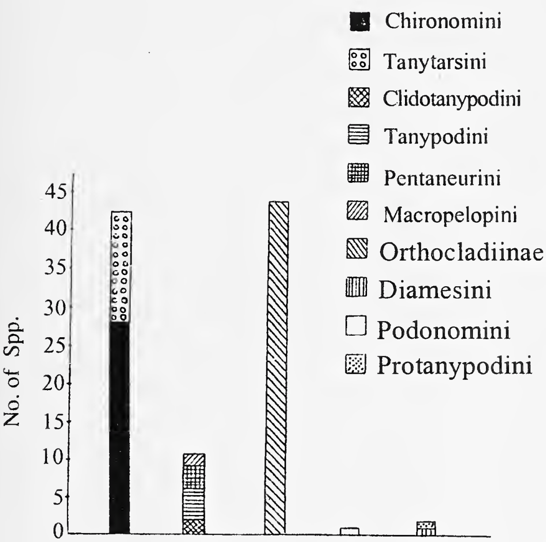

Fig. 1: Percentage analysis of species of Chironomidae from Indian limits

The material we collected represented five subfamilies: Orthocladiinae, Tanypodinae, Podonominae, Diamesinae and Chironominae, covering thirty-nine genera and 94 species. The majority were Orthocladiinae and Chironominae with 44.09% and 43.01% respectively, while Tanypodinae, Diamesinae and Podonominae were represented by 9.68%, 2.15% and 1.08% respectively.

PHYLOGENY OF CHIRONOMIDAE (FIG. 2)

Goetghebuer (1914) evaluated the phylogenetic relationships of Chironomidae. But except for his conclusion that the Chironominae were derived from the Orthocladiinae, most of his results have been found untenable. Our study reveals that the subfamily Telmatogetoninae belongs to a group with five other subfamilies viz. Podonominae, Tanypodinae, Diamesinae, Orthocladiinae, and Chironominae. These can be further divided into two phylogenetic groups of subfamilies namely Tanypodinae and Podonominae. The second group constitutes Diamesinae, Orthocladiinae and Chironominae.

ECOLOGY

No consistent work has been done on the ecology of Indian Chironomidae so far. Singh and Maheshwari (1987 a & b) reported that Chandertal (4,270 m. above msl), in the Lahaul-Spiti Valley has a chironomid community of five species. of *Micropsectra*; one species of *Metriocnemus* and three of *Corynoneura*. On the basis of their swarming behaviour, genera can be differentiated: *Micropsectra* spp. swarm over green vegetation while *Metriocnemus* spp. do so over stones and boulders. *Corynoneura* gyrates on the surface of lake water after emergence and each species of *Corynoneura* exhibits a specific pattern of gyration. Maheshwari (1992) studied Chironomidae as indicators of lake typology of Northwest Himalaya and categorized high altitude lakes into subgroups. A key for the classification of high altitude lakes is given below:

KEY TO THE TYPES OF LAKES ON THE BASIS OF CHIRONOMID FAUNA

1. *Paracladopelma* and Tanypodinae present…… .... Eutrophic lakes (Nanakmata)
   Above absent 2
2. *Heterotrissocladius, Stictochironomus* and *Phaenopsectra* present .... Mesotrophic lakes (Bhimtal, Sattal, Naukuchia Tal, Nainital)
   Micropsectra, Corynoneura, Diamesa, Pseudodiamesa and *Metriocnemus* present ...... Oligotrophic lakes 3
3. *Corynoneura* and *Micropsectra* (Notocene gp.). present.... zeta-Oligotrophic (Chandertal lake)
   Corynoneura spp. absent 4
4. *Micropsectra himachali, Diamesa dashauhari* and *Pseudodiamesa* present ....alpha oligotrophic (Dashauhar lake)
   Micropsectra himachali present. *Diamesa* and *Pseudodiamesa* spp. absent ....beta-oligotrophic...(Suraj Tal)

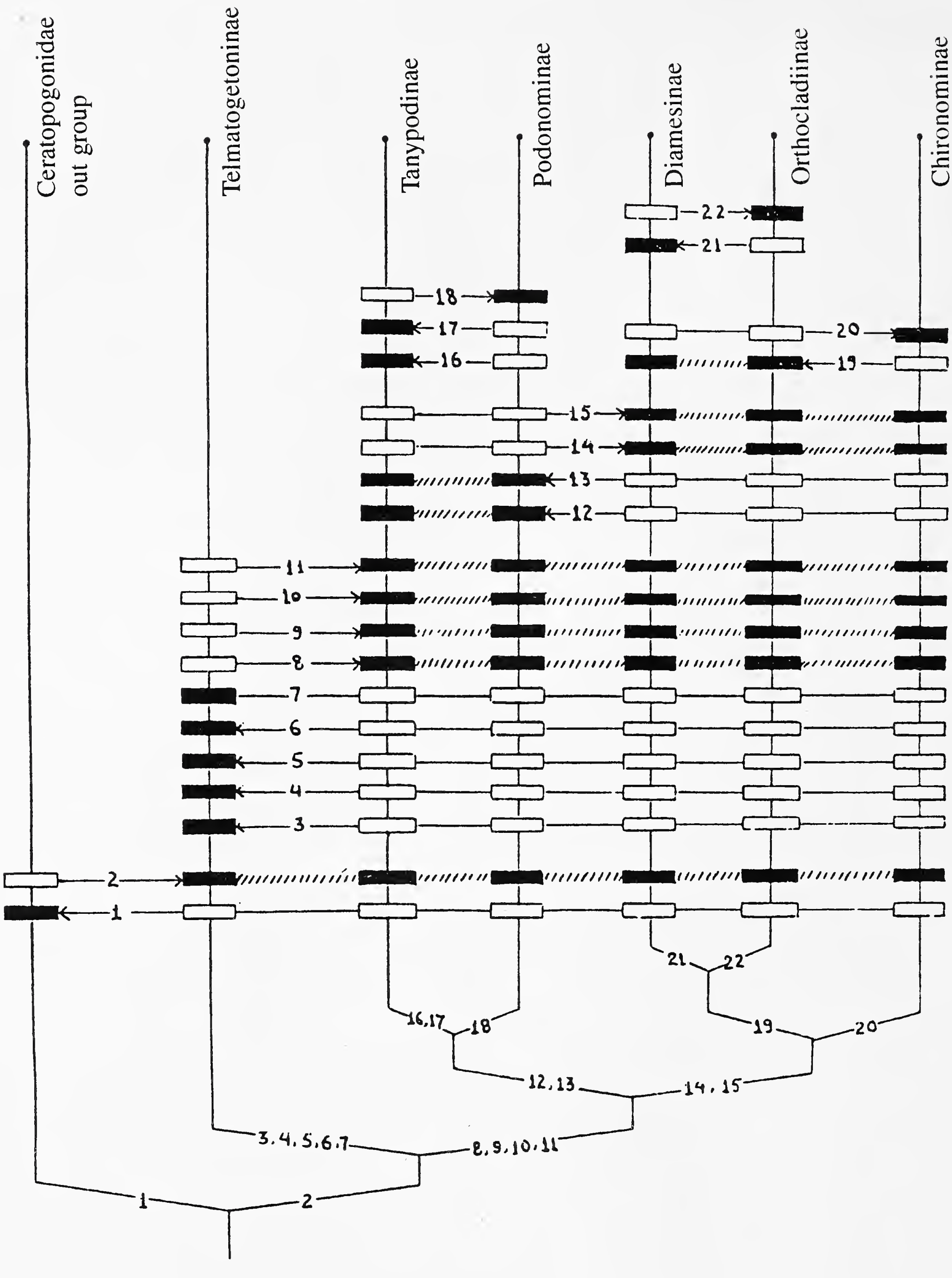

Fig. 2: Scheme of argumentation delineating the cladogenesis of the subfamilies of Chironomidae by means of trends 1-22.

Trends used in the cladistic analysis are being given hereunder (a = apomorphous; p = plesiomorphous)

Trend 1 Notum absent (a); notum present (p)
Trend 2 Anal point present (a); anal point absent (p)
Trend 3 Gonostylus male short and ovoid (a) male gonostylus long, tapering distally (p).
Trend 4 Tergite VIII of female reduced (a); Tergite VIII of female well developed (p).
Trend 5 Gonocoxite IX of female reduced (a); Gonocoxite IX well developed (p).
Trend 6 Female Labia fused (a); Labia separated.
Trend 7 Seminal capsule absent, spermathecal ducts serve as seminal storage organ (a); Seminal capsules present and well developed (p).
Trend 8 Gonapophysis VIII of female very long, elongated (p); Gonapophysis VIII relatively short, single or divided (a)
Trend 9 Gonostylus IX of female present (p); Gonostylus IX of female absent (a).
Trend 10 Gonostylus tooth, X and Y-seta absent (p); either tooth or X and Y- seta present (a).
Trend 11 Aedeagal membrane present in male (p); absent (a)
Trend 12 Tergite and sternite IX of male segment completely fused (a); Tergite and sternite IX not completely fused (p).
Trend 13 Gonocoxite of female reduced and fused with tergite IX to form gonotergite IX(a); both not fused (p).
Trend 14 One pair reduced volsella present (p); volsella 2-4 pairs and well developed (a).
Trend 15 Gonapophysis VIII of female not divided into 1-2 lobes (p); Gonapophysis VIII of female divided into 2-3 lobes (a).
Trend 16 Gonostylus tooth present (a); absent (p)
Trend 17 Gonotergite IX narrow and reduced with very few setae (a); gonotergite hood-shaped with numerous setae (p).
Trend 18 Female gonocoxapodeme VIII weakly developed (p); gonocoxapodeme VIII absent (a).
Trend 19 Tergite IX of female undivided, large, hood shaped (p); tergite IX divided into two setigerous protrusions. If undivided, shortened (a).
Trend 20 Male gonostylus posteriorly directed (a); anteriorly directed (p).
Trend 21 Segment X of male absent (a); segment X present (p).
Trend 12 Notum of female long (a); Notum relatively short (p).

As apparent from this key, the occurrence of specific forms in a particular water body indicate the character of the lake.

The present study reveals that occurrence of Chironomidae is related to the availability of appropriate larval habitat.

The species of tribe Chironomini are thermophilic and adapted to standing water. Tribe Tanytarsini includes rheophilic and thermophilic species. Rheophilic species represented by *Micropsectra* Tokunaga, represented by seven species, are restricted to the Himalayan Region. *Micropsectra chanderi* and *Micropsectra bifurcata* are also adapted to torrential streams. The rest of the *Micropsectra* species are found in the oligotrophic lakes of Himachal Pradesh. *Tanytarsus* Wulp and *Rheotanytarsus* Bause are thermophilic and lentic, while *Stempellina* Bause species are thermophilic and lotic. *Polypedilum* Kieffer species are found in marshy places.

Tanypodinae is represented by tribes Clinotanypodini, Tanypodini, Macropelopiini and Pentaneurini, are thermophilc, with a solitary example of rheophilic *Macropelopia* sp.

Orthocladiinae is a widely distributed group, inhabiting marine, marshy, lotic and lentic habitats in high altitude and low land water bodies. *Symbiocladius* Kieffer inhabits brackish water, running, stagnant water of low land and cold water bodies of Kulu Valley. *Corynoneura* Winn. are restricted to the ultra-oligotrophic lakes of Lahaul-Spiti Valley of Himachal Pradesh. *Cricotopus* Wulp are thermophilic and

TABLE 1

DISTRIBUTION OF INDIAN *CHIRONOMIDAE* IN RELATION TO HABITATS AND WATER CONDITIONS

	HABITATS					
	Marine	Brackish Water	Fresh Water			
			Rheophilous		Thermophilous	
			Lotic	Lentic	Lotic	Lentic
Chironomus	-	-	-	-	+	+
Paratendipes	-	-	-	-	+	+
Omisus	-	-	-	+	-	+
Endochironomus	-	-	-	-	-	+
Polypedilum	-	+	-	-	+	+
Xenochironomus	-	-	-	-	+	-
Microchironomus	-	+	+	-	+	+
Harnischia	-	-	-	-	+	+
Cladopelma	-	-	-	-	+	+
Parachironomus	-	-	-	-	-	+
Goeldichironomus	-	-	-	-	-	+
Glyptotendipes	-	+	-	-	-	+
Dicrotendipes	-	-	-	-	+	+
Leptochironomus	-	-	-	-	-	+
Micropsectra	-	-	+	+	-	-
Tanytarsus	-	-	-	-	-	+
Rheotanytarsus	-	-	-	-	-	+
Stempellina	-	-	-	-	+	-
Clinotanypus	-	-	-	-	+	+
Tanypus	-	-	-	-	+	+
Macropelopia	-	-	+	-	-	-
Pentaneura	-	-	-	-	+	+
Ablabesmyia	-	-	-	+	-	-
Conchapelopia	-	-	-	-	-	+
Cricotopus	-	-	-	-	-	+
Smittia	-	-	-	+	-	+
Krenosmittia	-	-	-	-	+	-
Thalassosmittia	+	-	-	-	-	-
Clinocladius	-	-	+	-	-	-
Metriocnemus	-	-	-	+	-	-
Brillia	-	-	+	-	-	-
Euricnemus	-	-	-	+	-	-
Corynoneura	-	-	-	+	-	-
Abiskomyia	-	-	+	-	-	-
Paraphenocladius	-	-	+	-	-	-
Symbiocladius	-	-	+	+	+	-
Podonomus	-	-	+	-	-	-
Diamesa	-	-	-	+	-	-
Pseudodiamesa	-	-	-	+	-	-

Key: (+) present; (-) absent.

lentic. *Smittia* Holmagren are adapted to thermophilic and rheophilic conditions. *Brillia* Kieffer and *Euricnemus* Wulp are the rarest chironomids of India, inhabiting cold water bodies of Kulu and Lahaul Valley, Himachal Pradesh. *Paraphenocladius* Thienemann is adapted for torrential streams. Among the Orthocladiinae, *Symbiocladius* Kieffer occur as external parasites on mayfly larvae. *Thalassosmittia* is exclusively marine.

During the last ten years, the high altitude lakes Suraj Tal (4864 m above msl), Chandertal (4270 m above msl), (Singh and Maheshwari 1987 a & b) Dashauhar Lake (4200 m above msl), (Singh and Maheshwari 1989), Bhrighu Lake (4132 m above msl), Deepak Tal (4202 m above msl) were explored and faual compositions of each lake was found specific. Dashauhar lake shows domination of *Diamesa-Pseudodiamesa,* whereas Bhrighu, Chandertal and Suraj Tal are dominated by *Micropsectra* species. Deepak Tal, a comparatively small lake, shelters a few species of Orthocladiinae (Maheshwari 1987).

Altitudinal Distribution

Chironomidae are abundant upto 5000 m above msl. A reduction in diversity with increasing altitude is observed in Chironomidae, only 35-40 species occuring over 2000 m. The Chironomini zone ranges 0-400 m above msl and supports 27 species with a single exception of *Glyptotendipes,* which was found between 1800-2000 m above msl (Kulu to Rhala fall). The Tanytarsini zone ranges from 0-5000 m and supports 14 species. *Micropsectra*, a high altitude group of Tanytarsini, is found distributed between 2000-5000 m above msl and represented by seven species (Kulu and Lahaul valley). Orthocladiinae inhabits marine water (Andaman and Nicobar Islands), low land water bodies in the plains of Uttar Pradesh, torrential streams and Himalayan lakes (Chandertal, Deepak Tal and Bhrighu lake). Podonominae and Diamesinae are exclusively hypsobiont and generally found above 2000 m.

Discussion

Although great overlaps occur, especially in the lower mountain and low land categories, there are distinct shifts in the Chironomidae community with increasing height. Substrate type and available food influences chironomid distribution as much as temperature. Most hypsobiont species have optimum temperature near their minimum tolerance value, whereas the warm water species or eurythermic species have a wider range of tolerance. The cold stenothermic species. were represented by *Diamesa, Pseudodiamesa* and some Orthocladiinae, those are restricted in ultra-oligotrophic lakes such as Dashauhar (Pir Panjal Range) and Suraj Tal lake (Great Himalayan Range). Similarly, *Corynoneura* spp. are only found in specific niches of Chandertal Lake in Lahaul Valley. On the other hand, *Micropsectra* are distributed throughout the Himalaya and adapted to lotic and lentic water bodies. Algal grazers such as Diamesinae and a few Orthocladiinae can dominate in glacial brooks and lakes. At the foothills, the shade of riparian vegetation diminishes algal grazer and increases scraper and collector species. This group comprises Tanytarsini, some Chironomini and most Orthocladiinae. In low land water bodies, due to low water velocity and high amount of particulate organic matter, filter and deposit feeding *Rheotanytarsus* and some species of Chironomini predominate.

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(HEIGHT IN METRES)

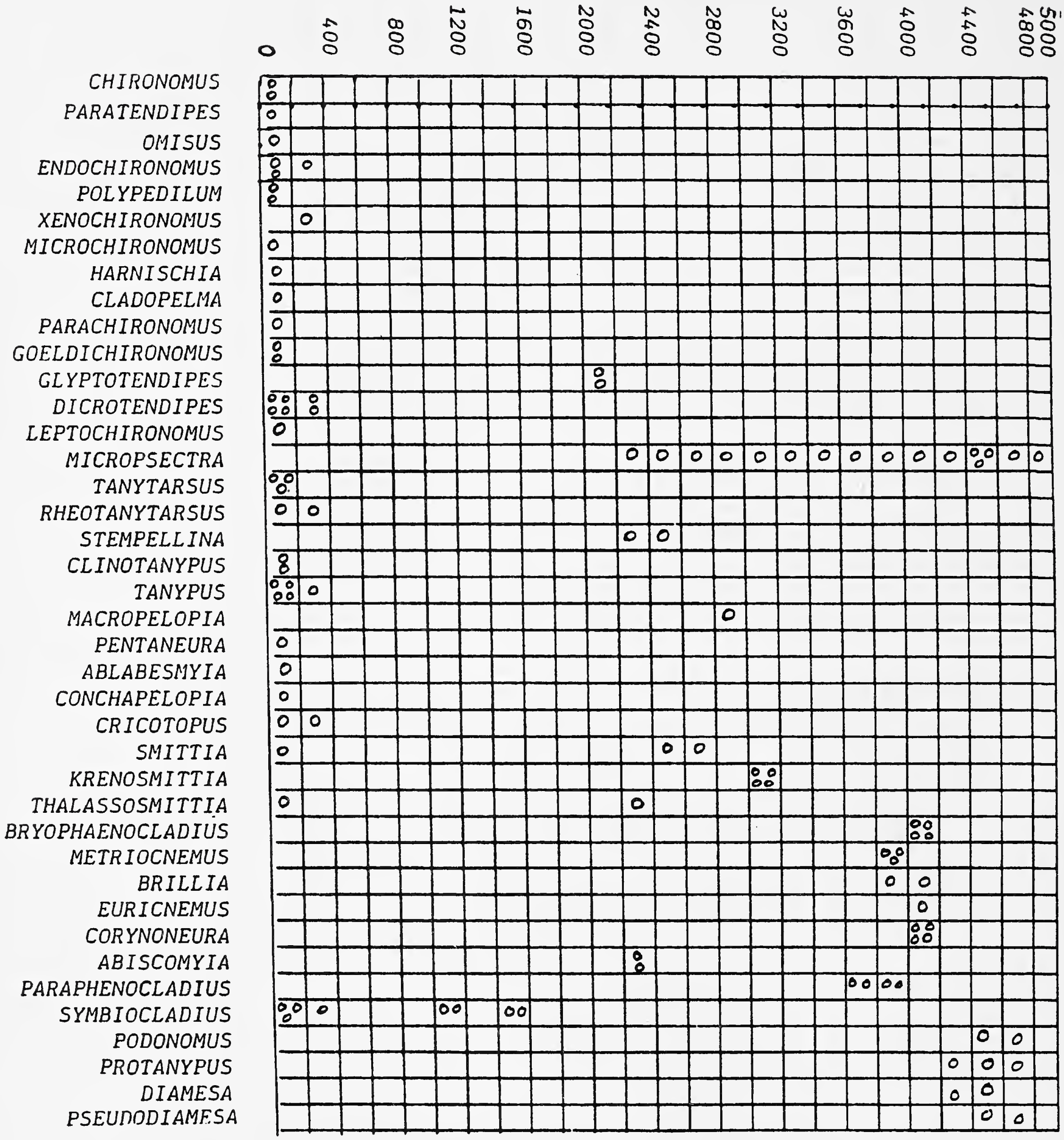

Fig. 3: Altitudinal distribution of Chironomidae

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FISHES OF PARAMBIKULAM WILDLIFE SANCTUARY, PALAKKAD DISTRICT, KERALA[1]

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(*With one text-figure*)

Key words: Parambikulam Wildlife Sanctuary, fish diversity, conservation measures.

A survey was conducted from December, 1996 to May, 1997 to document the freshwater fishes of Parambikulam Wildlife Sanctuary. Fishes were collected from 15 main localities and 15 subsites, using cast nets, gill nets and scoop nets. A total of 40 species of 12 families were collected. *Osteochilichthys longidorsalis, Barilius bendelisis* and *Glyptothorax lonah* are the important species recorded. The major threats to the fish fauna and recommendations for their conservation have been given.

INTRODUCTION

The hill streams and other water bodies located in the Western Ghats are rich in fish fauna. Of the 930 species of fish recorded in the lentic and lotic fresh waters of India, 168 are found in the Western Ghats (Singh, 1993). To conserve this fish diversity, special consideration should be given to freshwater bodies originating from Western Ghats. Pillay (1929), John (1936), Hora and Nair (1941) and Hora and Law (1941) reported the freshwater fishes of Kerala, especially from the Travancore region. This survey was conducted from December 1996 to May 1997 to document the freshwater fishes of Parambikulam Wildlife Sanctuary.

Physiography

Parambikulam Wildlife Sanctuary lies in a valley between Anaimalai and Nelliampathy hill ranges located in Palakkad district of Kerala, lying between 10° 20'-10° 32' N lat. and 76° 35' - 76° 5' E long. In 1973, 285 sq. km area of the Parambikulam valley was notified as a Wildlife Sanctuary contiguous with the Anaimalai Wildlife Sanctuary of Tamil Nadu across the border. The hills are covered with tropical evergreen and semi-evergreen forests along the western part of the sanctuary. Other vegetation types are moist teak bearing forests, South Indian moist deciduous forests and riparian fringing forests.

The main drainage systems in this Sanctuary include the rivers Karappara, Parambikulam and Thekkadiyar and their tributaries. The altitudes vary from 459 m to 1439 m above msl.

METHODS

The study area was visited during December 1996 to May 1997, and fishes were collected from 15 main localities and an equal number of subsites (Fig. 1). Cast nets, gillnets and scoop nets of varying mesh size were used. Works of Jayaram (1981), Talwar and Jhingran (1991) and Menon (1987, 1992) assisted in identification. Survey of India toposheets (1: 50,000) were used for the identification of approachable areas and to find out the order of streams. Some physical and chemical parameters were also measured. To avoid sampling error, collection methods were almost similar in all the sites.

RESULT AND DISCUSSION

The present survey indicates the richness of fish diversity in the drainage systems of Parambikulam Wildlife Sanctuary. A total of 40

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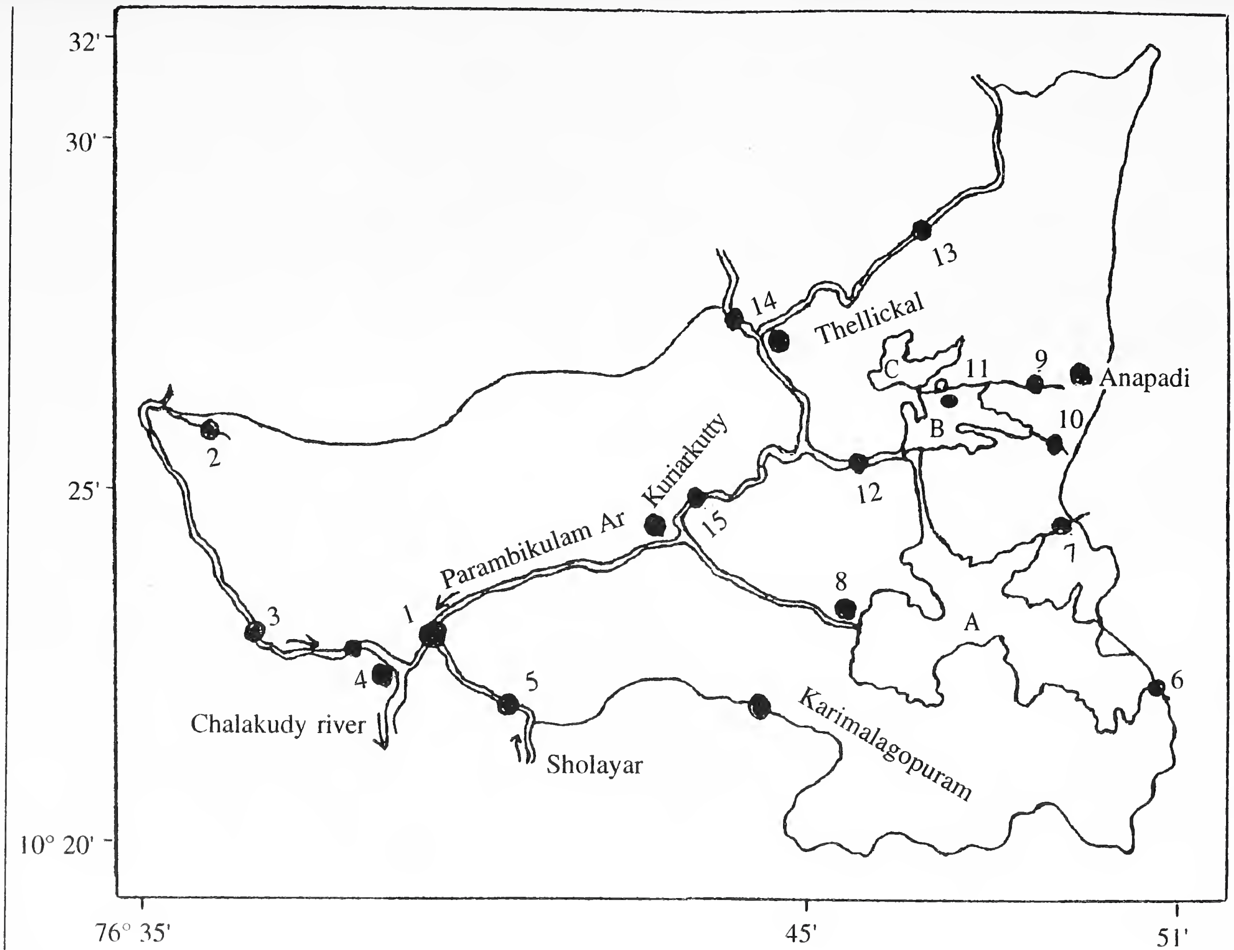

Collection sites (1-15)
1. Orukombankutty
2 Chakkali thodu
3. Karappara river
4. Karapparakutty
5. Orukomban
6. Panathiyar
7. Varagiliyar
8. Parambikulam dam site
9. Kolikamathithodu
10. Sichali pallm
11. Sungam
12. Thunakadavuar
13. Thekkadyar
14. Thellickalar
15. Kuriarkuttyar

A. Parambikulam Reservoir
B. Thunakadavu Reservoir
C. Peruvaripallam Reservoir

Fig. 1: Map of Parambikulam wildlife sanctuary showing various collection sites

TABLE 1

DISTRIBUTION OF FISHES IN DIFFERENT LOCALITIES IN PARAMBIKULAM WILDLIFE SANCTUARY

Species	Sites															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	t
FAMILY-ANGUILLIDAE																
1. *Anguilla bengalensis* (Gray)	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	3
FAMILY-CYPRINIDAE																
Sub family-Cyprininae																
2. *Puntius filamentosus* (Val.)	4	8	4	4	4	4	-	5	-	-	-	-	-	9	2	44
3. *Puntius carnaticus* (Jerdon)	8	2	5	-	-	-	6	9	-	-	3	-	4	2	4	43
4. *Puntius amphibius* (Val.)	2	4	-	-	5	-	-	2	-	-	-	-	-	-	-	13
5. *Puntius melanampyx* (Day)	8	12	2	10	5	6	12	5	8	4	2	4	8	-	-	86
6. *Puntius sarana subnasutus* (Val.)	6	-	-	-	4	-	-	5	-	-	-	-	-	2	-	17
7. *Puntius chola* (Ham.-Buch.)	2	-	-	-	-	-	-	2	-	-	-	-	-	-	4	8
8. *Catla catla* (Ham.-Buch.)	2	-	-	1	1	-	-	12	-	-	-	1	-	-	-	17
9. *Cirrhinus mrigala* (Ham.-Buch.)	-	-	-	-	-	-	-	8	-	-	-	1	-	-	-	9
10. *Gonoproktopterus curmuca* (Ham.-Buch.)	4	2	-	2	2	-	-	7	-	-	-	8	-	12	5	42
11. *Labeo rohita* (Ham.-Buch.)	1	-	-	-	-	-	-	9	-	-	-	-	-	-	-	10
12. *Tor khudree* (Sykes)	8	3	3	3	6	5	4	3	-	-	2	3	-	8	3	51
13. *Osteochilichthys longidorsalis* (Pethiyagoda & Kottelet)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Sub family - Rasborinae																
14. *Barilius bakeri* Day	6	4	4	4	5	-	6	2	2	8	-	-	-	-	-	41
15. *Barilius bendelisis* (Ham.-Buch.)	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	6
16. *Barilius gatensis* (Val.)	4	2	-	6	3	-	8	5	-	-	10	2	6	-	-	46
17. *Danio malabaricus* (Jerdon)	8	3	8	3	6	7	6	6	4	-	5	-	18	-	-	74
18. *Esomus danricus* (Ham.-Buch.)	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	8
19. *Parluciosoma daniconius* (Ham.-Buch.)	7	5	12	8	6	4	10	6	8	12	4	5	4	5	2	98
Sub family - Garrinae																
20. *Garra mullya* (Sykes)	8	6	4	10	6	6	5	6	3	-	2	1	8	11	7	83
21. *Garra surendranathanii* (Shaji *et al.*)	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Sub family - Baltorinae																
22. *Bhavania australis* (Jerdon)	-	-	-	-	2	-	8	-	-	-	-	-	-	-	-	10
23. *Travancoria jonesi* Hora	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-	3
Sub family - Nemacheilinae																
24. *Nemacheilus guentheri* Day	2	4	3	-	3	-	-	-	-	-	-	-	-	-	-	12
25. *Nemacheilus triangularis* Day	6	5	-	4	-	4	5	-	-	-	3	-	6	-	-	33
FAMILY - COBITIDAE																
Sub family - Cobitinae																
26. *Lepidocephalus thermalis* (Val.)	9	4	5	3	-	-	2	-	-	-	2	3	4	4	2	38

Collection sites — 1. Orukombankutty; 2. Chakkali thodu; 3. Karappara river; 4. Karaparakutty; 5. Orukomban; 6. Panathiyar; 7. Varagiliar; 8. Parambikulam dam site; 9. Kolikamathithodu; 10. Sichali pallam; 11. Sungam; 12. Thunakadavuar; 13. Thekkadiar; 14. Thellickalar; 15. Kuriarkuttiar; t - total number of specimens.

TABLE 1 (*contd.*)

DISTRIBUTION OF FISHES IN DIFFERENT LOCALITIES IN PARAMBIKULAM WILDLIFE SANCTUARY

Species	Sites															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	t
FAMILY-BAGRIDAE																
27. *Mystus armatus* (Day)	2	1	-	-	1	-	4	-	-	-	-	1	-	-	-	9
28. *Mystus malabaricus* (Jerdon)	2	-	2	-	-	-	-	-	-	-	-	-	2	-	-	6
FAMILY-SISORIDAE																
29. *Glyptothorax lonah* (Sykes)	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3
FAMILY-CLARIDAE																
30. *Clarias batrachus* (Linnaeus)	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2
FAMILY-APLOCHEILIDAE																
31. *Aplocheilus lineatus* (Val.)	10	-	-	4	2	1	8	2	-	-	3	2	-	4	3	39
FAMILY-NANDIDAE																
Sub family-Pristolepidinae																
32. *Pristolepis marginata* Jerdon	3	-	2	-	3	-	2	-	-	2	-	1	-	2	-	15
FAMILY-CICHLIDAE																
33. *Etroplus maculatus* (Bloch)	8	2	4	6	4	-	-	5	-	-	-	-	-	-	2	31
34. *Etroplus suratensis* (Bloch)	2	-	-	-	-	-	-	3	-	-	-	-	-	-	-	5
35. *Oreochromis mossambica* (Peters)	4	4	4	5	3	-	5	6	4	-	-	-	-	8	2	45
FAMILY-GOBIDAE																
36. *Glossogobius giuris* (Ham.-Buch.)	3	4	2	2	3	2	-	4	-	-	3	-	-	2	-	25
FAMILY-CHANNIDAE																
37. *Channa marulius* (Ham.-Buch.)	1	-	-	-	1	-	-	1	-	-	-	-	-	-	-	3
38. *Channa orientalis* (Bloch & Schneider)	-	-	2	-	1	-	-	-	1	-	-	-	-	-	-	4
FAMILY-MATACEMBELIDAE																
39. *Macrognathus guentheri* Day	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	2
40. *Mastacembelus armatus* (Lacepede)	1	-	-	1	-	-	1	-	-	-	2	-	-	-	-	5
Total no. of species	32	18	19	17	22	9	12	23	7	4	14	13	11	12	11	-

Collection sites — 1. Orukombankutty; 2. Chakkali thodu; 3. Karappara river; 4. Karaparakutty; 5. Orukomban; 6. Panathiyar; 7. Varagiliar; 8. Parambikulam dam site; 9. Kolikamathithodu; 10. Sichali pallam; 11. Sungam; 12. Thunakadavuar; 13. Thekkadiar; 14. Thellickalar; 15. Kuriarkuttiar; t - total number of specimens.

species belonging to 12 families were collected from various localities (Table 1). Of these, 3 were culture fishes. Most of the species are widely distributed in Kerala and other parts of Western Ghats. *Garra mullya, Puntius melanampyx, Barilius gatensis, Parluciosoma daniconius, Danio malabaricus, Nemachellus triangularis* and *Lepidocephalus thermalis* were uniformly distributed in this Sanctuary. *Puntius carnaticus, Gonoproktopterus curmuca, Tor khudree, Barilius bakeri, Esomus danricus, Nemacheilus guentheri, Mystus armatus, Clarias batrachus, Etroplus suratensis, Channa marulius* and *Anguilla bengalensis* were comparatively rare. *Bhavania australis* and *Travancoria jonesi* were confined upstream in the Parambikulam river.

Osteochilichthys longidorsalis was recently discovered from the lower reaches of Athirapilly waterfalls, Chalakudy river (Pethiyagoda and Kottelet 1996) and collected

by us from Parambikulam river near Orukombankutty. This is the second report of this fish from the same river. *Garra surendranathanii* was collected from its type locality (Shaji *et al.* 1996). *Barilius bendelisis*, which has been reported only from the east flowing Pambar river in Kerala, was reported for the first time from a west flowing river system (Raju Thomas *et al.* 1998). *Glyptothorax lonah* collected from Karappara river was its first record in Kerala (Biju *et al.* 1998). *Tor khudree,* the Deccan Mahseer was well represented at almost all sites.

Freshwater fish diversity was very high (32 species recorded) in the Orukombankutty, the confluence of Karappara, Sholayar and Parambikulam rivers. This area had deep pools and ditches and the bottom was rocky or sandy in most parts. Hence special consideration should be given to protection of this habitat, as it harbours a large number of fish species.

Values of physical and chemical parameters varied with the change in the habitats. The temperature varied between 23°C-26.5°C and pH was 6.5-8.1. The value of dissolved oxygen was between 6 - 8.1 mg/1.

Major Threats and Recommendations for the Conservation of Fish fauna

Anthropogenic alterations of the forest habitat cause great changes in rivers and their fish fauna. Spreading of fish diseaes, mainly due to pollution, is another threat facing the fish fauna. Due to these reasons, some groups of fishes have become rare and endangered. These fishes need immediate protection to save them from extinction. Some recommendations are:

1. A separate fish sanctuary should be established in the rivers flowing through this area.
2. Regular monitoring of water quality.
3. Existing suitable habitats should be protected from erosion and deterioration of water quality.
4. Further introduction of exotic fishes should stop.
5. Extensive use of traps, long lines and explosives should be curtailed.
6. River bank restoration should be started in damaged areas with suitable riparian vegetation in the Anaimalai and Nelliampathi hill ranges.

Though Parambikulam is a deemed sanctuary with very little human interference, the Orukombankutty area, with its highly diverse fish fauna, must be monitored to protect it.

Acknowledgement

We thank Dr. K. Rema Devi, Scientist, ZSI, Southern Regional Station, Chennai, for confirming our identification of the fishes.

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■ ■ ■

A PRELIMINARY SURVEY OF LICHENS FROM CORBETT NATIONAL PARK[1]

D.K. Upreti and S. Chatterjee[2]

(*With three text-figures*)

Key words: Lichen, epiphytic, Corbett National Park

The paper enumerates 69 species representing 21 genera of lichens found growing on different tree species in seven forest sites in Jim Corbett National Park, Uttar Pradesh, India. It also includes a comparative account of lichens growing on different phorophytes. The crustose lichens exhibit dominance on trees.

Introduction

Corbett National Park was established on 8th August, 1936 and happens to be the oldest National Park of the Indian subcontinent. The park is located between 29° 13' and 29° 35' N lat., and between 78° 46' and 79° 33' E long., spread over an area of 1318.54 sq. km. It is situated in the foothills of Himalayas, mainly in the districts of Pauri Garhwal and Naini Tal. The park contains two protected areas within its precincts, namely Corbett National park (CNP) 520.82 sq. km and Sonanadi Wild Life Sanctuary (WLS) 301.18 sq. km.

As the park lies in the Shivalik-terai biotic province abutting the Himalayas, it has great habitat diversity. The northern side of the park is bounded by mountains of outer Himalayas, while the drier Shivalik range lies on the south. The rainfed Ramganga river enters the park at Marchula, and before emerging out of the park at Kalagarh, Mandal, Palain and Sonanadi are its main tributaries. Construction of a dam across the Ramganga at Kalagarh led to the formation of a large man-made reservoir spread over an area of 82 sq. km.

Vegetation: *Acacia catechu* (Khair) and *Dalbergia latifolia* (Sissu) forest thrive in riverine areas, while *Shorea robusta* forests are found on hilly slopes and ridges. About one tenth of the park has open grasslands. Dhikala, Paterpani, Kinnanauli, Bijrani and Jhirna are some of the important grasslands of the park.

The common associates of *Shorea robusta* are evergreen species of *Mallotus philippensis* and *Syzygium cumini.* The other small to medium sized trees are *Phoebe lanceolata, Litsea glutinosa, L. monopetala, Drypetus roxburghii* and *Boehmeria rugulosa. Murraya, Mangifera indica* and *Citrus medica* grow in mixed and pure patches.

Among the deciduous species, *Terminalia alata, T. chebula, Semecarpus anacardium, Lannea coromandelica, Sapium insigne,* and *Lagerstroemia parviflora* are common at Dhikala, Bijrani, and Malani. Paterpani also harbours *Acacia catechu, Holoptelea integrifolia* and *Phyllanthus emblica. Dalbergia sissoo* occupies large patches in Dhikala and Paterpani. *Bischofia javanica, Firmiana pallens* and *Ficus* species are very common in Sultan. Shrubs or small trees of *Murraya koenigii* are scattered throughout the park.

Pant (1987) enumerated 594 species of angiosperms, and 22 ferns and fern allies from the park. The cryptogamic flora, however, have not received adequate attention so far.

Material and Methods

In this study, seven forest localities (Bijrani, Malani, Dhikala, Jhirna, Chuhi, Sultan

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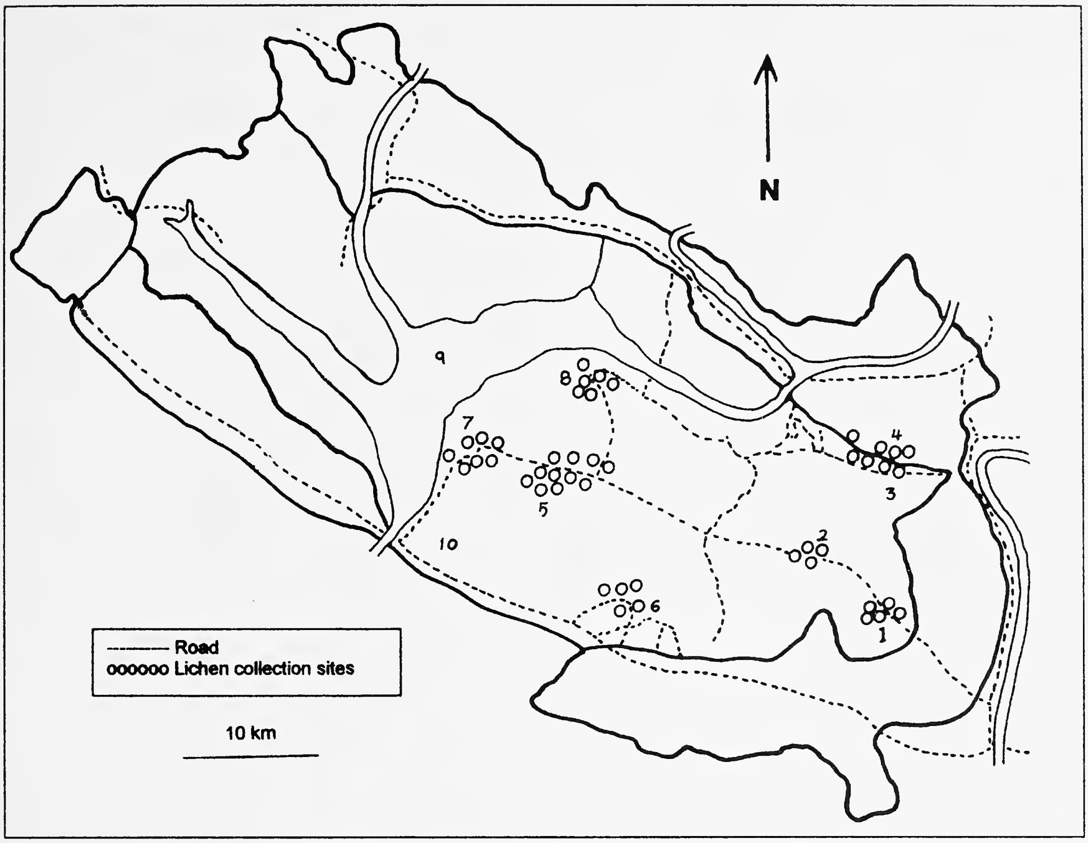

Fig. 1: Map showing Lichen collection sites in Corbett National Park
1. Bijrani; 2. Malani; 3. Dhangari; 4. Sultan; 5. Paterpani; 6. Jhirna; 7. Saddle Dam; 8. Dhikala; 9. Ramganga Reservoir; 10. Kalagarh

and Paterpani) in the core zone of the park were surveyed (Fig. 1) and about 300 lichen specimens were collected, growing over trees of *Syzygium cumini, Mallotus philippensis, Murraya koenigii, Mangifera indica, Shorea robusta, Terminalia arjuna* and *Toona ciliata,* and on sandstone and other rocks.

The specimens were studied anatomically, morphologically and chemically. They are now preserved in the lichen herbarium of the National Botanical Research Institute (LWG).

Results and Discussion

A total of 69 species representing 21 genera of lichens were found growing on trees, sandstone and other rocks in the area surveyed. There is dominance of crustose form of lichens, in all the seven forest sites (Fig. 2) represented by 62 species, while only 7 foliose species of three genera *Dirinaria, Parmelia* and *Physcia* were found on *Syzygium cumini, Murraya koenigii, Shorea robusta* and *Terminalia arjuna* in the moist area of Malani, Sultan, Paterpani and Chuhi.

Syzygium cumini trees, the most common associates of *Shorea robusta* in moist places along streams, harbour 45 epiphytic species, while *Shorea robusta, Mallotus philippensis* and *Murraya koenigii* bear 15, 7 and 8 lichen species respectively (Tables 1-4).

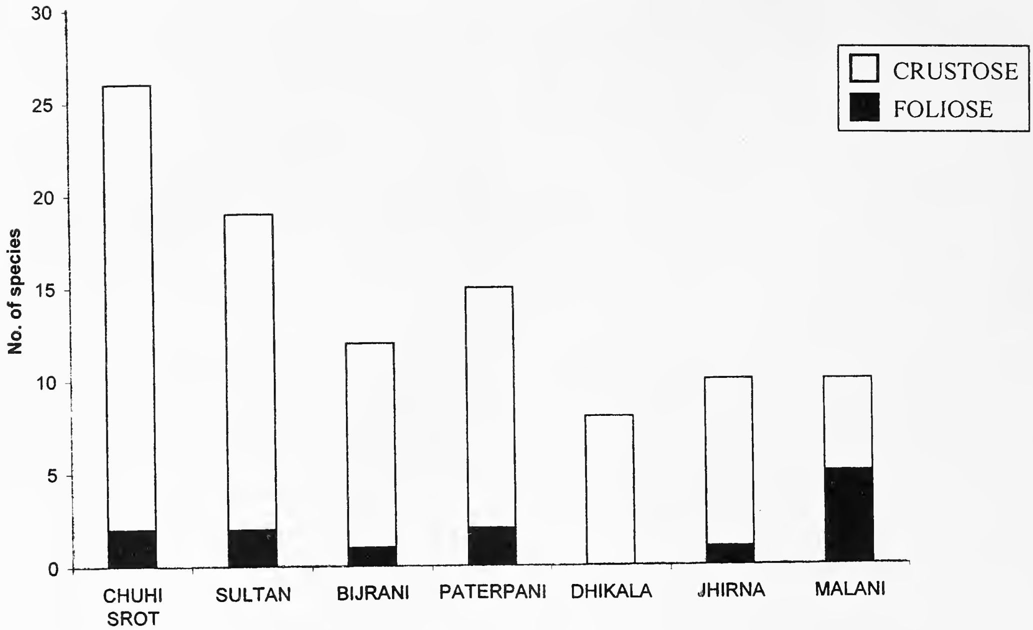

Fig. 2: Growth form types of lichens in different forest sites of Corbett National Park

An orange-yellow crustose lichen *Brigantiaea leucoxantha*, commonly grows on *Syzygium cumini*, in moist and also dry places in the park, while on trees in moist, damp, shaded areas, along the stream, the pyrenocarpous lichen *Pyrenula* dominates with seven species. Chuhi Srot and Sultan areas have the maximum diversity of epiphytic lichens on *Syzygium cumini*, as represented by 23 and 18 species respectively (Table 1). *Syzygium* trees in more or less dry areas of Malani, Jhirna and Dhikala bear only 2, 3 and 5 lichen species respectively.

Trees of *Shorea robusta* bear 15 epiphytic species of lichen. Young trees of *Shorea robusta* have smooth and soft bark, preferred by the crustose species *Lecanora cinereofusca*, *L. pulicaris* and *Chrysothrix candelaris* in Malani and Paterpani areas. In mature *Shorea robusta* trees, the bark is thick and rough. Mature trees in dry places show poor growth of a few crustose lichens like *Bacidia*, *Caloplaca* and *Pertusaria*, while at moist, shady places they bear foliose lichen genera *Parmelia* and *Leptogium*.

It is interesting to note that decaying logs of *Shorea robusta* in moist places of Malani area have a luxuriant growth of both crustose (*Brigantiaea* and *Buellia*) and foliose (*Parmelia*, *Dirinaria* and *Physcia*) species.

Mallotus philippensis trees have hard wood, with a thin, smooth, upper surface, preferred by only a few pyrenocarpous and graphidaceous genera. The trees exhibit no growth of foliose lichens. Due to its smooth bark, *Mallotus philippensis* shares 4 and 2 common epiphytic species with *Syzygium cumini* and *Murraya koenigii* respectively, whereas it does not share any species with the thick, rough barked *Shorea robusta* (Fig. 3).

Murraya koenigii, an evergreen shrub or small tree, with smooth bark on the trunk, is scattered throughout the park. It is common in more or less dry, open areas of Paterpani, and Jhirna area, and bears 8 species, of which two are

TABLE 1
LICHENS ON *SYZYGIUM CUMINI* IN CORBETT NATIONAL PARK

Sl. No.	Lichen species	Location
1.	*Arthonia inpolitella* Nyl	C
2.	*A. medusula* (Pers.) Nyl.	C
3.	*A. radiata* (Pers.) Nyl.	C
4.	*A. subgyrosa* Nyl.	S
5.	*Arthonia* sp.	B
6.	*Bacidia covexula* (Müll. Arg.) Zahlbr.	S
7.	*B. medialis* (Tuck. in Nyl.) Zahlbr.	B, D, P
8.	*B. nigrofusca* (Müll. Arg.) Zahlbr.	P, J
9.	*B. rufescens* (Müll. Arg.) Zahlbr	P
10.	*Brigantiaea leucoxantha* (Sprengel) R. Sant & Haf. in Haf. & Ballem	B, S, D, C
11.	*Caloplaca subnigricans* Magn.	C
12.	*Chrysothrix candelaris* (L.) Laudon	C
13.	*Cryptothecia lunulata* (Zahlbr.) Makh. & Patw.	B, S, P, C
14.	*Dirinaria aegialita* (Afr. in Ach.) Moore	S
15.	*D. confluens* (Fr.) Awasthi	M
16.	*Graphina* cfr. *cleistoblephara* (Nyl.) Zahlbr.	D, C
17.	*G.* cfr. *dimorphodes* (Nyl.) Zahlbr.	B
18.	*Graphis divaricoides* Räsänen	C
19.	*G. implexula* Stirton	C
20.	*G. nakanishiana* Pat. & Kulk.	B, S, P, C
21.	*G. nigroglauca* Leighton	C
22.	*G. subashinae* Nagarkar & Patw.	C
23.	*G. scripta* (L.) Ach.	B, P, C
24.	*Lecanora cinereofusca* H. Magn.	J
25.	*L. fimbriatula* Stirton	S
26.	*L. perplexa* Brodo	B, C
27.	*Lecidea* sp.	S, C
28.	*Opegrapha inaequalis* Feé	P
29.	*O. rufescens* Pers.	S
30.	*O. vulgata* Ach.	S
31.	*Parmelia saccatiloba* Taylor	C
32.	*Pertusaria himalayensis* Awasthi & Srivastava	P, C
33.	*P. depressa* (Feé) Mont & v.d. Bosch.	C
34.	*P. leioplacella* Nyl.	S, J
35.	*P. punctata* Nyl.	S
36.	*Physcia clementei* (Sm. in Sm. & Sorv.) Lynge	M
37.	*Phaeographis instrata* (Stirton) Zahlbr.	C
38.	*P. subdividens* (Leighton) Müll. Arg.	C
39.	*Pyrenula aspistea* (Ach.) Ach.	S
40.	*P. conspercata* Müll. Arg.	B
41.	*P. immersa* Müll. Arg.	S
42.	*P. immissa* (Stirton) Müll. Arg.	S
43.	*P. introducta* (Stirton) Zahlbr.	S
44.	*P. mastophorizans* Müll. Arg.	S
45.	*P. sublaevigata* (Patw. & Makh.) Upreti	S

B: Bijrani, C: Chuhi, D: Dhikala, J: Jhirna, M: Malani, P: Paterpani, S: Sultan.

TABLE 2
LICHENS ON *SHOREA ROBUSTA* IN CORBETT NATIONAL PARK

Sl. No.	Lichen species	Location
1.	*Bacidia* cfr. *laurocerasi* (Delise ex Duby) Ozenda & Clauz	D
2.	*Brigantiaea leucoxantha* (Sprengel) R. Sant & Haf in Haf & Bellem	P
3.	*Buellia curtisii* (Tuck.) Imsh. in Brodo	M
4.	*Caloplaca malaensis* (Räsänen) Awasthi	M
5.	*Chrysothrix candelaris* (L.) Laudon	M
6.	*Dirinaria aegialita* (Afz. in Ach.) Moore	M
7.	*Lecanora cinereofusca* H. Magn.	M
8.	*L. pulicaris* (Pers.) Ach.	M, P
9.	*Leptogium austroamericanum* (Malme) Dodge	S
10.	*Parmelia praesorediosa* Nyl.	M
11.	*P. tinctorum* Nyl.	M, B
12.	*Pertusaria concinna* Erichsen	M
13.	*P. quassiae* (Feé) Nyl.	M
14.	*Physcia clementei* (Sm. in Sm. & Sow.) Lynge	M
15.	*Phaeographis albolabiata* Pat. & Kulk.	J

B: Bijrani, C: Chuhi, D: Dhikala, J: Jhirna, M: Malani, P: Paterpani, S: Sultan.

TABLE 3
LICHENS ON *MALLOTUS PHILIPPENSIS* IN CORBETT NATIONAL PARK

Sl. No.	Lichen species	Location
1.	*Bacidia nigrofusca* (Müll. Arg.) Zahlbr.	J
2.	*B. nigrosticta* Zahlbr.	B
3.	*Graphina* cfr. *dimorphodes* (Nyl.) Zahlbr.	P
4.	*Graphis nakanishiana* Pat. & Kulk.	P
5.	*Lecanora perplexa* Brodo	P
6.	*Pertusaria acuta* Müll. Arg.	M
7.	*Pyrenula albida* Müll. Arg.	B
8.	*P. brunnea* Feé	M
9.	*P. subrizalensis*	C

B: Bijrani, C: Chuhi, D: Dhikala, J: Jhirna, M: Malani, P: Paterpani, S: Sultan

foliose and six crustose. It shares two species with *Mallotus* and 4 with *Syzygium cumini* (Fig. 3).

CONCLUSION

The major conclusions that emerge from this study are as follows:

TABLE 4
LICHENS ON *MURRAYA KOENIGII* IN CORBETT NATIONAL PARK

Sl. No.	Lichen species	Location
1.	*Bacidia nigrofusca* (Müll. Arg.) Zahlbr.	J
2.	*Cryptothecia stirtonii* A.L. Smith	J
3.	*Dirinaria confluens* (Fr.) Awasthi	J
4.	*Lecanora perplexa* Brodo.	P
5.	*Lecanora xylophila* Hue	C
6.	*Parmelia saccatiloba* Taylor	P
7.	*Pertusaria acuta* Müll. Arg.	P
8.	*Pyrenula aspistea* (Ach.) Ach.	P

B: Bijrani, C: Chuhi, D: Dhikala, J: Jhirna, M: Malani, P: Paterpani, S: Sultan.

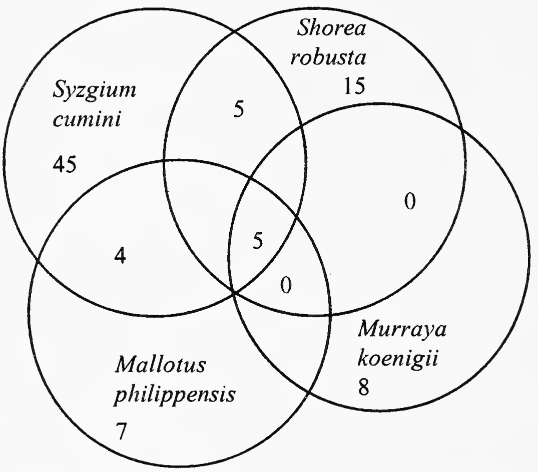

Fig. 3: Common epiphytic lichens species sharing different trees in Corbett National Park

■ In all the sites surveyed crustose lichens dominate, except at Malani, where only foliose lichens were found growing on decaying logs of *Shorea robusta*.

TABLE 5
LICHENS ON *MANGIFERA INDICA* IN CORBETT NATIONAL PARK

Sl. No.	Lichen species	Location
1.	*Bacidia medialis* (Tuck. in Nyl.) Zahlbr.	S
2.	*Pyrenula introducta* (Stirton) Zahlbr.	S

B: Bijrani, C: Chuhi, D: Dhikala, J: Jhirna, M: Malani, P: Paterpani, S: Sultan.

■ The Chuhi and Sultan areas are lichen-rich, having 26 and 20 species respectively, as both are moist, and shady sites with luxuriant growth of evergreen *Syzygium cumini* and *Mallotus philippensis*.

■ *Syzygium cumini* bears 23 epiphytic lichen species, followed by *Shorea roubsta, Murraya koenigii,* and *Mallotus philippensis* with 15, 8 and 7 species respectively.

■ *Mangifera indica* is preferred by some specific lichen species of pyrenocarpous genera.

■ *Terminalia arjuna* and *Toona ciliata* show poor growth of only a few lichen species.

ACKNOWLEDGEMENTS

We are grateful to the Director, National Botanical Research Institute, Lucknow, for providing laboratory facilities, to the authorities of Corbett National Park, for extending all help during survey and collection, and to Mr. Murari Ranjan and Jyoti Tandon for laboratory assistance.

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ADDITIONS TO THE FLORA OF HIMACHAL PRADESH FROM SIRMAUR DISTRICT[1]

M. SHARMA AND HARSIMERJIT KAUR[2]

Key Words: New records, flora, Sirmaur.

51 species of flowering plants recorded from Sirmaur district of Himachal Pradesh, hitherto not reported from the State, have been listed along with pertinent information on their habits and habitat.

INTRODUCTION

Ever since June 1984, the senior author and his students have been engaged in the districtwise systematic survey of the flora of Himachal Pradesh in Northwest Himalaya. Consequently, besides three new introductions to Indian flora (Singh and Sharma 1988, Dhaliwal and Sharma 1995, Sharma and Dhaliwal 1997 a), new records of 28 species from Chamba dist. (Sharma and Singh, in press) and 32 species from Kulu dist. (Sharma and Dhaliwal 1997 b) have been made for Himachal Pradesh. In this communication, we enumerate, along with some pertinent information, 51 species of flowering plants from Sirmaur dist. which have not been reported earlier from Himachal Pradesh. These were gathered during our extensive and intensive field studies of the district during 1991-1994. But for minor modifications, to conform to current circumscription of taxa, the arrangement of the families is after Hooker (1872-1897). Unless otherwise stated, all the specimens cited here are conserved in the Punjabi University Herbarium, Patiala (PUN).

RANUNCULACEAE

Clematis buchananiana DC. var. *vitifolia* Wall. ex Hook.f. & Thoms.
Common in forests, 1500-2500 m.
Fl. & Fr.: August - September.
Shasholi (Rajgarh), Harsimerjit 17634.

[1]Accepted January, 1998
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ANNONACEAE

Annona squamosa Linn.
Rare, in tropical forests, 1000-1500 m.
Fl. & Fr.: May - September.
Nahan, Harsimerjit 18302 & 18926.

MENISPERMACEAE

Cocculus hirsutus (Linn.) Diels
Rare, 500-1000 m.
Fl. & Fr.: February - May.
Nahan, Sangrah; Harsimerjit 18424 & 18603, 18604.

BRASSICACEAE

Malcolmia africana (Linn.) R.Br.
Rare in dry areas, 500-700 m.
Fl. & Fr.: February - May.
Paonta Sahib, Harsimerjit 18334 & 18436.

CAPPARACEAE

Capparis zeylanica Linn.
Rare among hedges, 500-600 m.
Fl. & Fr.: April-May.
Paonta Sahib, Harsimerjit 17622.

CARYOPHYLLACEAE

Spergula fallax (Lowe) Krause
Common weed of cultivation, fallow fields and moist wasteland, 400-1100 m.
Fl. & Fr.: January-March.
Nahan, Harsimerjit 18432.

MALVACEAE

Abutilon persicum (Burm.f.) Pers.
Common, 400-1500 m.
Fl. & Fr.: March-May.
Kolar (Paonta Sahib), Batapul, Yashwant Nagar; Harsimerjit 18610, 18611, 18704.

Hibiscus hirtus Linn.
Rare, 400-600 m.
Fl. & Fr.: August-October.
Paonta Sahib, Harsimerjit 18909.

TILIACEAE

Corchorus capsularis Linn.
Rare, 400-600 m.
Fl. & Fr.: August-October.
Kala Amb, Harsimerjit 18310 & 18912.

C. tridens Linn.
Common in wasteland, 400-600 m.
Fl. & Fr.: July-October.
Dadahu, Kala Amb, Chandni, Batapul, Dholakuan; Harsimerjit 17603 & 18913, 17609, 18308, 18309, 18914.

OXALIDACEAE

Biophytum reinwardtii (Zucc.) Klotz
Sataun, Karki 90047 (BSD).

SAPINDACEAE

Cardiospermum halicacabum Linn. var. *microcarpum* (Kunth) Blume
Common climber, 500-1700 m.
Fl. & Fr.: August-October.
Nahan, Dadahu; Harsimerjit 17654, 18950.

PAPILIONACEAE

Desmodium pulchellum (Linn.) Benth.
Common undergrowth in forests, 1000-1800 m.
Fl. & Fr.: August-October.
Nahan, Sainwala, Sarahan; Harsimerjit 18376, 18377, 19571.

Indigofera tinctoria Linn.
Common in waste places, 500-1000 m.
Fl. & Fr.: August-November.
Sangrah, Nahan, Renuka, Dholakuan, Paonta Sahib; Harsimerjit 18465 & 18650, 18466, 18657, 18777, 18778.

Rhynchosia minima (Linn.) DC. var. *laxiflora* (Camb.) Baker
Common among hedges, 400-600 m.
Fl. & Fr.: July-October.
Paonta Sahib, Harsimerjit 18358.

CAESALPINIACEAE

Cassia leschenaultiana DC.
Rare in grassy fields, 800-1500 m.
Fl. & Fr.: August-November.
Nahan, Harsimerjit 19774.

MIMOSACEAE

Acacia leucophloea (Roxb.) Willd.
Common, 400-500 m.
Fl. & Fr.: October-December, March-May.
Kala Amb, Harsimerjit 19234.

Prosopis juliflora (Sw.) DC.
Common and gregarious on undisturbed ground, 400-700 m.
Fl. & Fr.: March-May.
Sangrah, Sainwala; Harsimerjit 19237, 19547.

LYTHRACEAE

Rotala mexicana Cham. & Schlecht.
Rare in marshes and rice fields, 1000-1500 m.
Fl. & Fr.: September-January.
Nahan, Harsimerjit 19190.

Cucurbitaceae

Luffa echinata Roxb. var. *longistyla* Clarke

Occasionally found among hedges, 400-1000 m.

Fl. & Fr.: August-October.

Renuka, Harsimerjit 19913.

Momordica balsamina Linn.

Rare among hedges or on trees, 400-700 m.

Fl. & Fr.: April-October.

Renuka, Harsimerjit 19744.

M. charantia Linn. var. *muricata* (Willd.) Chakravarty

Rare climber in tropical zone, 400-1000 m.

Fl. & Fr.: July-October.

Nahan, Moginand (Kala Amb); Harsimerjit 19276, 19767.

Cactaceae

Nopalaea cochenillifera (Linn.) Salm-Dyck

Rare, 400-1000 m.

Fl.: January - May, September - October. **Fr.**: December - January.

Sangrah, Harsimerjit 19238.

Opuntia monacantha (Willd.) Haw.

Common in waste places, 450-1800 m.

Fl. & Fr.: April-October.

Kala Amb, Harsimerjit 19263.

Rubiaceae

Oldenlandia gracilis (Wall.) Hook.f.

Sarahan, Vohra 946281 (BSD).

Asteraceae

Chrysanthellum americanum (Linn.) Vatke

Common in grassy areas, 400-1500 m.

Fl. & Fr.: August-November.

Nauradhar, Haripurdhar; Harsimerjit 19307 & 19390, 19323.

Sphaeranthus senegalensis DC.

Rare in moist grassy fields, 400-1000 m.

Fl. & Fr.: November - May.

Paonta Sahib, Harsimerjit 19509.

Vicoa vestita (Wall. ex DC.) Benth. ex Hook.f.

Rare, 400-1000 m.

Fl. & Fr.: March-May.

Nahan, Harsimerjit 19604.

Gentianaceae

Centaurium centaurioides (Roxb.) Rolla Rao & Hemadri

Rare in grassy fields, 400-700 m.

Fl. & Fr.: March-May.

Chandni, Harsimerjit 19035.

Solanaceae

Datura tatula Linn.

Occasionally found in wasteland, 500-1000 m.

Fl. & Fr.: August-September.

Chandni, Renuka; Harsimerjit 18399, 18835.

Scrophulariaceae

Bacopa procumbens (Linn.) Greenm.

Common on sandy river beds, 400-1000 m.

Fl. & Fr.: March-May.

Sainwala, Bherewala; Harsimerjit 18563 & 19545, 18798.

Scoparia dulcis Linn.

Common, 600-1500 m.

Fl. & Fr.: July - December.

Paonta Sahib, Harsimerjit 17155.

Veronica polita Fries

Common in moist grassy fields, 400-2000 m.

Fl. & Fr.: December-April.

Nahan, Harsimerjit 17154.

LAMIACEAE

Ocimum gratissimum Linn.
Cultivated, often grows as an escape in wasteland, 500-1000 m.
Fl. & Fr.: December-March.
Nahan, Sirmuri Tal; Harsimerjit 18678, 19667.

Prunella vulgaris Linn. var. *hispida* Benth.
Common, 1400-3000 m.
Fl. & Fr.: March-October.
Nauradhar, Haripurdhar; Harsimerjit 18522, 18584.

Salvia coccinea Juss. ex Murr. var. *pseudococcinea* (Juss. ex Murr.) Gray
Common near Nahan cantonment road, 900-1000 m.
Fl. & Fr.: August-October.
Nahan, Harsimerjit 18592.

AMARANTHACEAE

Alternanthera tenella Colla
Very common, 400-1000 m.
Fl. & Fr.: February-April.
Paonta Sahib, Kala Amb; Harsimerjit 19017, 19094.

PHYTOLACCACEAE

Rivinia humilis Linn.
Common in hedges, gardens and wasteland, 500-1500 m.
Fl. & Fr.: July-November.
Shilai, Harsimerjit 19354.

EUPHORBIACEAE

Croton bonplandianum Baill.
Common in waste places, 500-1000 m.
Fl. & Fr.: March-November.
Dadahu, Sirmuri Tal, Sundraghat (Sangrah), Kala Amb, Paonta Sahib; Harsimerjit 17129, 18843, 18897, 19112, 19413.

Euphorbia pilosa Linn. var. *cognata* Hook.f.
Very common as forest undergrowth especially on way to Churdhar, 2400-2800 m.
Fl. & Fr.: June-September.
Churdhar, Nauradhar; Harsimerjit 18686, 19491.

PONTEDERIACEAE

Eichhornia crassipes (Mart.) Solms
Occasionally found in ponds, 400-600 m.
Fl.: August-November, April-May.
Batapul, Paonta Sahib; Harsimerjit 17363, 19373.

COMMELINACEAE

Commelina suffruticosa Blume
Rare in rice fields, 400-1000 m.
Fl. & Fr.: July-October.
Paonta Sahib, Harsimerjit 19168.

ARACEAE

Colocasia esculenta (Linn.) Schott
Common in marshy places especially near Renuka Lake, 400-1000 m.
Fl. & Fr.: August-November.
Renuka, Harsimerjit 19681.

CYPERACEAE

Cyperus nutans Vahl var. *eleusinoides* (Kunth) Haines
Common in marshy places and rice fields, 400-1500 m.
Fl. & Fr.: July-October.
Paonta Sahib, Harsimerjit 19752.

POACEAE

Cenchrus setigerus Vahl
Common in waste places, 500-1000 m.
Fl. & Fr.: August-November, March-April.

Nahan, Paonta Sahib; Harsimerjit 19246, 19258.

Chrysopogon aciculatus (Retz.) Trin.

Common as forest undergrowth, 1000-1500 m.

Fl. & Fr.: July-November.

Sarahan, Harsimerjit 19400.

Cyrtococcum patens (Linn.) A. Camus

Rare in sandy areas, 400-1500 m.

Fl. & Fr.: August-November.

Nahan, Harsimerjit 18858.

Dinebra retroflexa (Vahl) Panz.

Common on dry slopes, 400-1500 m.

Fl. & Fr.: August-October.

Nahan, Shilai, Paonta Sahib; Harsimerjit 19247, 19272, 19533.

Eragrostis ciliaris (Linn.) R.Br.

Rare in cultivated fields, 400-1000 m.

Fl. & Fr.: March-May.

Paonta Sahib, Harsimerjit 19536.

E. tenella (Linn.) P. Beauv. ex Roem. & Schult. var. *insularis* Hubb.

Common in agricultural fields and lawns, 400-1500 m.

Fl. & Fr.: August-October.

Nahan, Shilai; Harsimerjit 16898, 19353.

Panicum walense Mez

Common in sandy localities, 400-1000 m.

Fl. & Fr.: August-November.

Sainwala, Nahan; Harsimerjit 18859, 19315.

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NEW DESCRIPTIONS

NEW HUNTSMAN SPIDERS (HETEROPODIDAE: ARANEAE) FROM BUXA TIGER RESERVE, JALPAIGURI, WEST BENGAL[1]

MADHUCHHANDA KUNDU (DEB),[2] VIVEKANAND BISWAS[3] AND DINENDRA RAYCHAUDHURI[2]

(*With thirteen text-figures and one plate*)

Key words: Spiders, Heteropodidae, *Heteropoda straminiosa* sp. nov., *Olios tikaderi* sp. nov., Buxa Tiger Reserve, West Bengal, India

Two new species, *Heteropoda straminiosa* sp. nov. and *Olios tikaderi* sp. nov. are described and illustrated from Buxa Tiger Reserve, Jalpaiguri, West Bengal.

INTRODUCTION

Huntsman spiders (Heteropodidae: Araneae) of West Bengal are so far known by 7 species of *Heteropoda* Latreille and 3 of *Olios* Walckenaer (Biswas and Biswas 1992, Sethi and Tikader 1988), and from Buxa Tiger Reserve by 2 species, namely, *Heteropoda leprosa* Simon (Biswas and Biswas 1992) and *Heteropoda buxa* Saha *et. al.* (Saha *et al.* 1994, 1995).

Both *Heteropoda straminiosa* and *Olios tikaderi* have been recognized as new species after comparing them with the types deposited in the National Collection, Zoological Survey of India, Calcutta. The species are described and illustrated. Type specimens are at present in the collection of the Entomology Laboratory, Department of Zoology, University of Calcutta, Calcutta. Collection of further material from the type locality will enable us to deposit the material in the National Collection, Zoological Survey of India, Calcutta.

MATERIAL AND METHODS

Collection and preservation of the spider samples were done following Tikader (1987). The material was studied using a stereozoom binocular microscope, model Zeiss, SV8. All the measurements are in millimetres, made with an eyepiece graticule.

The status of the two species has been confirmed following Biswas and Biswas (1992), Pocock (1900), Sethi and Tikader (1988) and Tikader (1987).

Heteropoda straminiosa sp. nov.
(Figs. 1-6; Plate 1A)

Holotype: FEMALE: Total length 8.43; carapace length 3.14, width 2.90; abdominal length 5.28, width 3.43. Legs as in Table 1.

Colour in alcohol: Cephalothorax, legs and abdomen yellowish with small brown spots all over, those on abdomen more dense and heavy, particularly on the posterior part.

Carapace: Slightly longer than wide, anteriorly narrow; cephalic region slightly raised, marked by weakly impressed cervical grooves that enclose a weaker brown median longitudinal line; anterior margin of cephalothorax straight with the anterolateral corners raised and conical, with a few long brown hairs, otherwise with short thinly distributed brown hairs; thoracic region with a deeply distinct longitudinal fovea, encircled by thinly distributed short brown hairs, extending posteriorly as a deeply distinct longitudinal groove; cephalothorax midlongitudinally with faint brown U-shaped patch,

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Kundu M., Biswas V. & Raychaudhuri D.: New Huntsman spiders PLATE 1

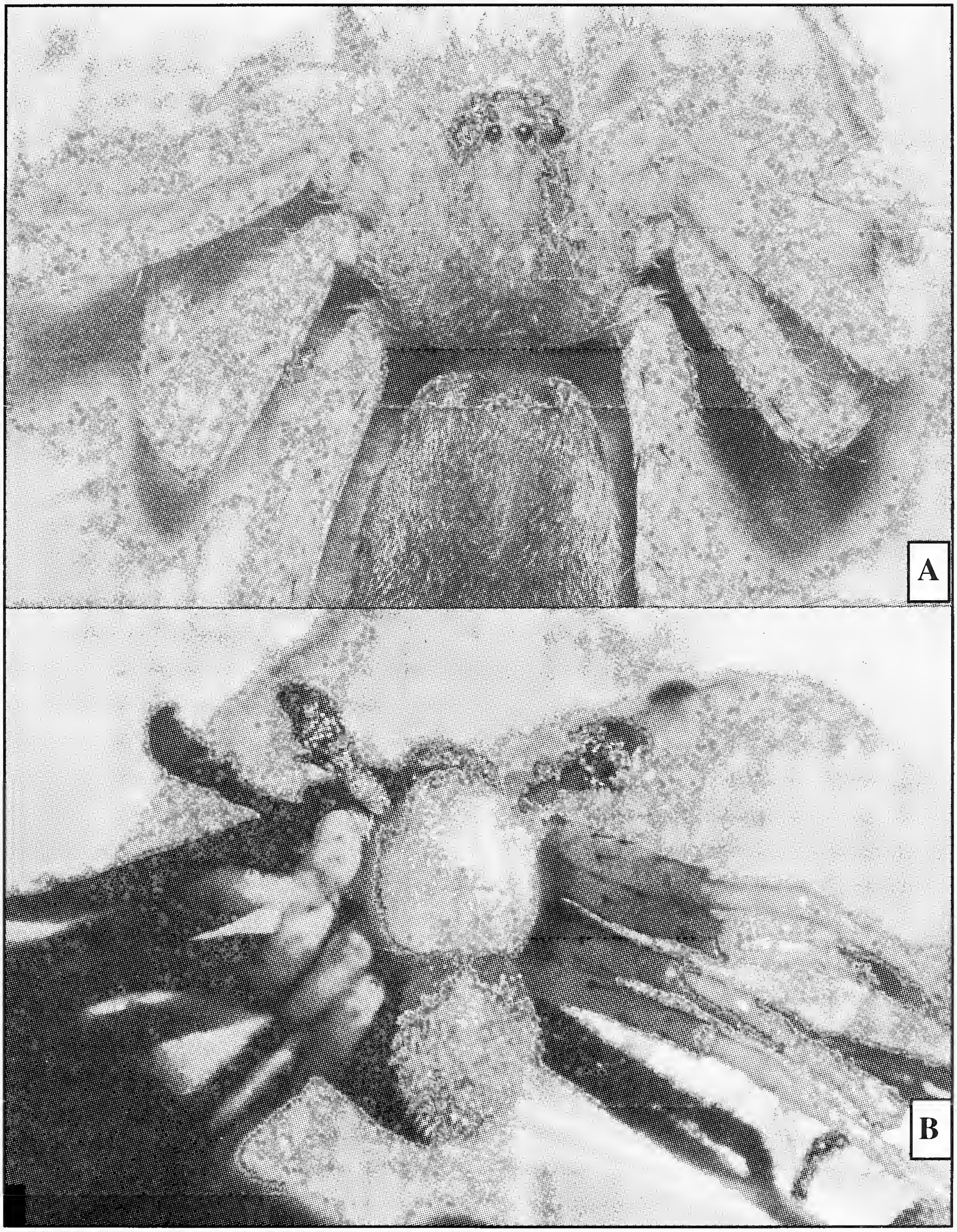
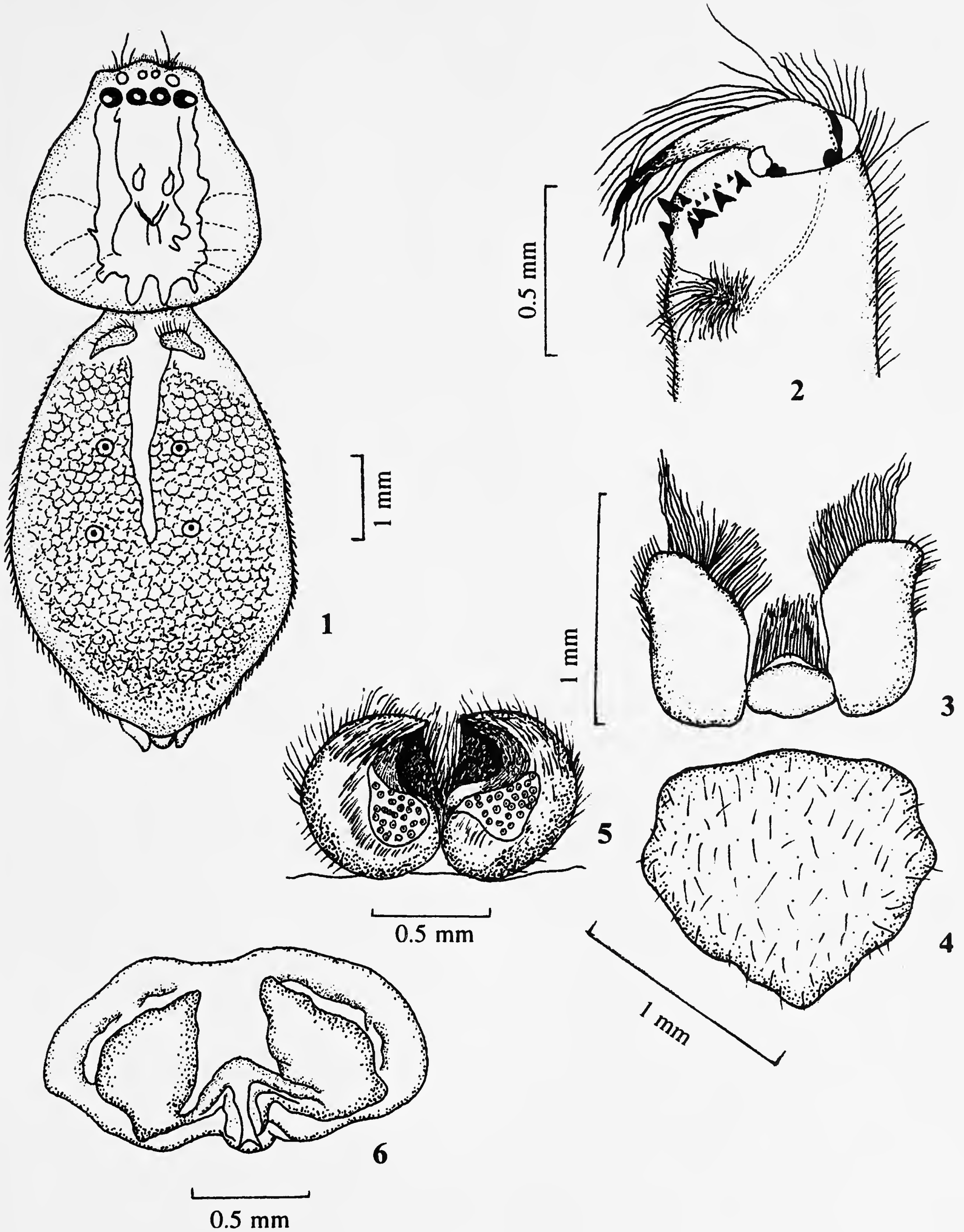


Fig. A: *Heteropoda straminiosa* sp. nov. Female: Holotype

Fig. B: *Olios tikaderi* sp. nov. Male: Holotype



Figs. 1-6: *Heteropoda straminiosa* sp. n., female holotype:
1. Whole body; 2. Chelicerae; 3. Maxillae and labium; 4. Sternum; 5. Epigynum; 6. Internal genitalia

extending upto the posterolateral eyes marked by brownish pubescence; outwardly directed faint radii present. Eyes in two rows, with black patches, on brownish area, anterior row shorter than posterior row; anterior row of eyes procurved as seen from in front and posterior row recurved as seen from above; laterals subequal, anteromedians smallest; posterolaterals situated on somewhat elevated tubercle; ocular quad longer than wide, wider posteriorly. Chelicerae strong, yellowish with dark brown dorsal spots, inner margin with 4 teeth and outer with 3; area between the margins with a few much smaller teeth; each with a ventral tuft of long hair on brown patch at the inner aspect of cheliceral base, fangs reddish brown, strongly curved. Labium and maxillae yellowish, the latter anteriorly brownish; labium wider than long, maxillae longer than wide, both thickly scopulate. Sternum yellowish, nearly triangular, anteromedially wide, posteriorly narrowing, with brown spots and long and short pale yellow to brown hairs. Legs moderate, basally yellowish, gradually becoming brown; tibia with long paired ventral spines; tarsal scopulae distinct; Leg formula 2143.

Abdomen: elongate oval, dorsum anteriorly yellowish, posteriorly brownish, anteriorly with a pair of dark median brown patches, marked by cluster of brown hairs; midlongitudinally with yellowish bar, entirely clothed with golden yellow hairs and pubescence, these posteriorly longer, a few anterior hairs brown; sigilla two pairs. Venter yellow, with scattered brown longitudinal bands, these midlongitudinally broad and narrowed posteriorly; entirely clothed with golden and brown hairs. Epigynum with paired comma-shaped lateral lobes, basally close to each other, divergent anteriorly, forming a depression; epigynum and internal genitalia as in Figs. 5 & 6.

Male unknown.

Specimen examined: *Holotype*, Female, South Volka, BTR, Jalpaiguri, West Bengal, India, 27.xii.1995, Coll. V. Biswas. **Paratypes**, 5 females, data same as holotype.

TABLE 1
MEASUREMENTS OF LEG SEGMENTS OF *HETEROPODA STRAMINIOSA* SP. NOV. (FEMALE)

Leg	Femur	Patella & Tibia	Metatarsus	Tarsus	Total
I	3.8/3.8	4.1/4.1	3.3/3.3	0.9/0.9	12.1/12.1
II	4.1/4.1	4.3/4.3	3.0/3.0	1.2/1.2	12.6/12.6
III	3.5/3.5	3.5/3.5	2.4/2.4	0.8/0.8	10.2/10.2
IV	3.6/3.6	3.7/3.7	3.2/3.2	1.0/1.0	11.5/11.5

Distribution: INDIA: West Bengal, Jalpaiguri (known only from the type locality).

Remarks: The new species shows close affinity to *Heteropoda akashi* Sethi and Tikader (Sethi and Tikader 1988), in being similar in general appearance, chelicerae, maxillae and labium, but distinct in having:

1) Carapace and legs with distinct small brown spots,
2) Faintly impressed cervical grooves,
3) Weakly recurved posterior row of eyes,
4) Chelicerae with an additional row of small teeth between the margins,
5) Abdomen with a midlongitudinal band and anterolaterally with a pair of dark brown patches bearing cluster of hairs,
6) Epigyne, spermathecae and spermathecal ducts quite different.

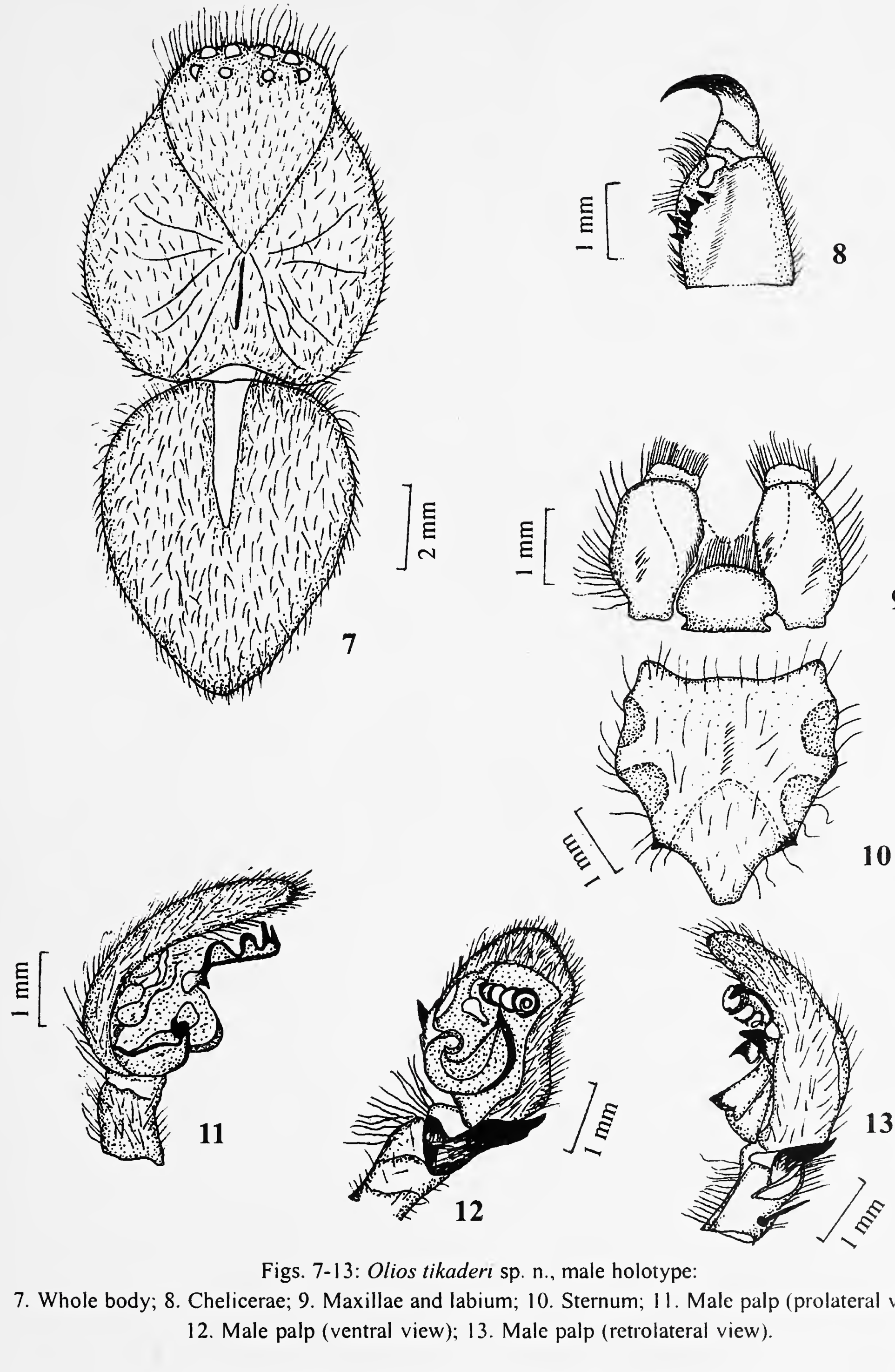
These differences justify the recognition of the species as new to science.

Etymology: The species *Heteropoda straminiosa* is so named because of its yellow colour.

Olios tikaderi sp. nov.
(Figs. 7-13; Plate 1B)

Holotype: one MALE: Total length 15.41; carapace length 8.00, width 7.59; abdominal length 7.41, width 5.76. Legs as in Table 2.

Colour in alcohol: Cephalothorax orangish with cephalic part anteriorly reddish; legs yellowish, gradually becoming darker distally, abdomen greyish.



Figs. 7-13: *Olios tikaderi* sp. n., male holotype:
7. Whole body; 8. Chelicerae; 9. Maxillae and labium; 10. Sternum; 11. Male palp (prolateral view); 12. Male palp (ventral view); 13. Male palp (retrolateral view).

Carapace: Longer than wide, convex, clothed with hairs and spines; cephalic region raised, cervical furrows weakly distinct, thoracic fovea reddish, longitudinal, deeply distinct, radii weakly distinct, clypeal and ocular regions with some long, black bristles. Eyes in two rows, anterior row from above slightly recurved and posterior row slightly procurved; anteromedians largest; ocular quad squarish, narrowing anteriorly. Chelicerae long, reddish, inner and outer margins with 5 and 2 teeth respectively, fangs black, robust. Labium and maxillae both yellowish brown, anteriorly thickly scopulate; labium wider than long with a lateral notch on each side; maxillae longer than wide. Sternum orangish, convex, nearly heart-shaped, with long brown hairs. Legs long and strong, hairy; all tibiae with two pairs of ventral spines. Leg formula 2143. Male palp as in Figs. 11, 12 and 13.

Abdomen: Heart-shaped, anteriorly broad and posteriorly tapered, with long golden hairs, dorsum midlongitudinally with a yellowish streak extending on the anterior half. Venter greyish with a midlongitudinal brownish bar extending from epigastric furrow to the spinnerets.

TABLE 2
MEASUREMENTS OF LEG SEGMENTS OF *OLIOS TIKADERI* SP. NOV. (MALE)

Leg	Femur	Patella & Tibia	Metatarsus	Tarsus	Total
I	11.5/11.5	16.5/16.5	11.0/11.0	3.0/3.0	42.0/42.0
II	13.5/13.5	17.5/17.5	13.0/13.0	3.0/3.0	47.0/47.0
III	8.5/8.5	13.0/13.0	9.5/9.5	2.5/2.5	33.5/33.5
IV	11.0/11.0	14.0/14.0	11.0/11.0	2.5/2.5	38.5/38.5

Specimen examined: **Holotype**, Male, Jayanti, BTR, Jalpaiguri, West Bengal, India, 24.v.1995, Coll. B. Kundu.

Distribution: INDIA: West Bengal, Jalpaiguri (known only from the type locality).

Remarks: The present species is closely allied to *Olios xerxes* (Pocock) but differs in the following:
1) Body entirely clothed with long hairs,
2) Carapace broader than abdomen, with distinct cervical furrows and radii,
3) Abdomen anteriorly broad and posteriorly tapering, dorsum anteromedially with a yellowish streak and devoid of any sigilla, and
4) Structurally different male palp.

Again, the species is distinct from *Olios punctipes* Simon, even though the male palps are similar, by the following characters:
1) Carapace longer than wide,
2) Labium with a lateral notch
3) Abdomen peripherally devoid of dark patch and without any sigilla,
4) Structure of cymbium,
5) Structure and origin of retrolateral apophysis.

The species is therefore new to science, this has been confirmed by the Zoological Survey of India, Calcutta.

Etymology: The species is named after a great Indian arachnologist, the late Dr. B.K. Tikader.

ACKNOWLEDGEMENTS

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A NEW SPECIES OF AGAONID WASP (HYMENOPTERA, CHALCIDOIDEA) POLLINATING *FICUS KRISHNAE* C.DC. (MORACEAE)[1]

D.R. Priyadarsanan[2,3]

(*With sixteen text-figures*)

Key words: *Eupristina (E.) rehmani, Eupristina (E.) masoni, Eupristina (E.) belgaumensis, Ficus krishnae, F. drupaceae* var. *pubescens, F. benghalensis.*

Eupristina (Eupristina) rehmani sp. nov. pollinating *Ficus krishnae* C.DC. is described and a short note on the taxonomic status of the host plant is given.

Introduction

The fruits of all species of *Ficus* are colonized by a heterogenous group of insects of the family Agaonidae (Hymenoptera, Chalcidoidea), commonly called fig insects or fig wasps. Fig insects of the subfamily Agaoninae are the exclusive pollinators of their hosts. Genus *Eupristina* Saunders are the pollinators of *Ficus* spp. of section *Conosycea* (Miq.) to which *Ficus krishnae* C.DC. belongs. *Ficus krishnae* is a small to medium sized banyan, commonly known as 'Krishna bor' or 'butter cup of Krishna'. This tree has a fair distribution in North and Central India, but is rare in South India.

An agaonid pollinator of *F. krishnae* is described here and the taxonomic status of its host *Ficus* is evaluated.

The type specimens are presently kept in the collection of the Museum of Department of Zoology, University of Calicut (ZDC).

Eupristina (Eupristina) rehmani sp. nov.

Female

Length 2.2 mm; colour generally black, antennal scape, femur and coxa yellowish on ventral side.

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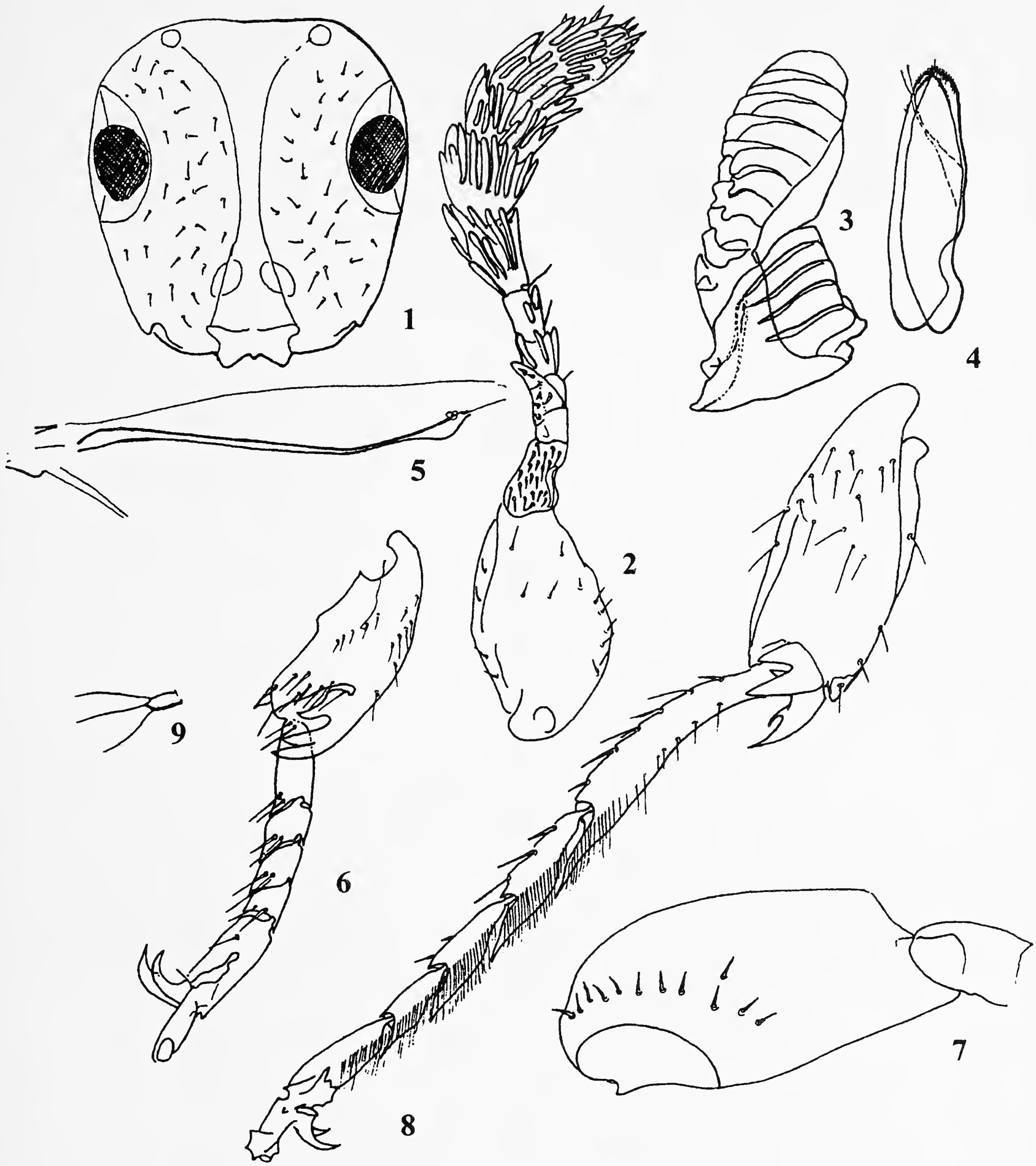
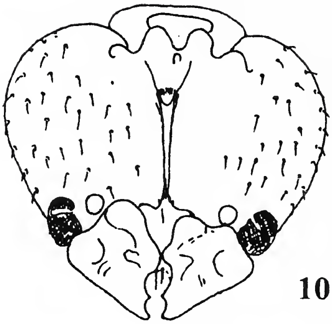
Head: (Fig. 1) almost as long as wide and 2.5 times the longitudinal diameter of the compound eye (5:2); eyes positioned a little posteriorly; cheek almost equal to eye length, margins of the facial groove more divergent anteriorly.

Antenna (Fig. 2) 11 segmented, scape almost twice its own width; pedicel one third the length of scape and less than twice its maximum width (10:6), bears 22 backwardly directed spines on the dorsal side; appendage of the 3rd segment blunt, bears a few spines and reaches the middle of the 5th; 4th segment less than twice its own width (10:6); 5th segment almost equal to 4th, as long as its own width, and bears 4 sensillae; 6th segment is the narrowest and it bears two sensillae; 7th segment is the largest, twice the length of the 5th and 1.5 times its own width, and bears 16 sensillae in two rows; 8th segment two-thirds the length of 7th and of its own width (21:15) and bears 16 sensillae; 9th segment half the length of 7th and its own width (12:21) and provided with a distal row of 16 sensillae; 10th segment as wide as long, and as long as the 9th bearing 12 sensillae; 11th segment forms a club, and bears 16 sensillae and a few setae. Mandible (Fig. 3) as long as wide, bidentate, two glands and with 5 ventral ridges; mandibular appendage twice the length of the mandible, thrice its own width, 10 lamellae present, and first 6 lamellae produced into lateral teeth; labio-maxillary complex (Fig. 4), the labium bearing two setae.



Figs. 1-9: *Eupristina* (*Eupristina*) *rehmani* sp. nov. Female:
1. Head; 2. Antenna; 3. Mandible; 4. Labio-maxillary complex; 5. Forewing; 6. Foretibia & tarsus; 7. Hind coxa; 8. Hindtibia & tarsus; 9. Pygostyle.
(Figs. 1 & 5 X100, 2-4 & 6-9 X400)



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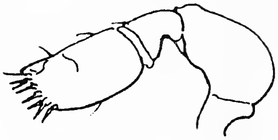

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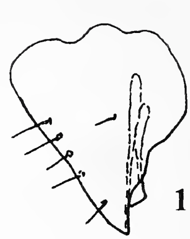

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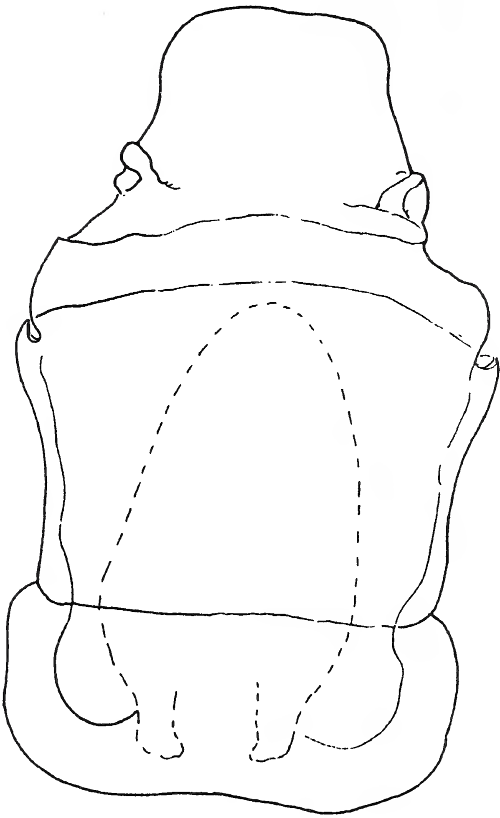

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Figs. 10-16: *Eupristina (Eupristina) rehmani* sp. nov. Male:
10. Head; 11. Antenna 12. Mandible; 13. Thorax; 14. Foretibia & tarsus; 15. Midtibia & tarsus; 16. Hindtibia & tarsus.
(Figs. 10 & 13 X100, 11, 12 & 14-16 X400)

Thorax: Pronotum 1.5 times its own width, slightly pubescent; pronotum, mesonotum and metanotopropodeum in the ratio 8:4:3. Propodeal spiracles elongate, flask-shaped. Forewing (Fig. 5) twice its own width, 1.2 mm long, hyaline, only premarginal vein developed, which reaches two fifths the length of the wing and bears 3 pustules at its distal end. Hindwing 0.82 mm, venation not distinct, fringe long and middorsally there is a tuft of a few hairs. Foreleg coxa with comb and corbicula; femur bears 6 setae at the basal ventral corner, arranged in a semicircle; tibia (Fig. 6) ventrally curved and with a deep apical invagination; tibial armature consists of a dorso-apical comb of 3 claws, ventral tooth and a few long setae; tarsus pentamerous, each tarsomere with two prominent subapical setae, tarsomeres in ratio 2:1:1:1:2. Midleg coxa 4:3, femur with a tapering apex, length width ratio 4:1, tibia with shortest width at the base and maximum at the apex bearing long curved claw ventrally and a few setae at the apex; tarsomeres in the ratio 8:5:5:4:6. Hindleg coxa (Fig. 7) with a circlet of spines proximally; tibial armature (Fig. 8) consists of a tricuspid tooth antiaxially and a long curved bifid tooth at the ventral apex; tarsomeres in the ratio 12:7:6:4:7.

Gaster: Normal; pygostyle (Fig. 9) with 4 setae, 2 apical (only one visible dorsally) and two subapical; protruding part of the ovipositor 1.4 mm.

MALE

Vermiform, length 1.9 mm; colour dark brown, legs pale yellow except dorsal half of hind coxa.

Head: (Fig. 10) Slightly wider than long, longitudinal diameter of eye one fifth the length of the head; compound eyes and the antennae placed just behind the mandibles; shortest distance between the antennal toruli and the distance from the antennal toruli to the compound eyes are in the ratio 5:1. Antenna (Fig. 11) 4 segmented; scape length: width ratio 2:1; scape, pedicel and club in the ratio 2:1:2. Mandible (Fig. 12) 5:4, bidentate, two glands.

Thorax: (Fig. 13) Pronotum, mesonotum and metanotopropodeum in the ratio 3:1:2. Foreleg coxa (4:3) proximally tapering; femur (2:1) as long as coxa; tibia (Fig. 14) has a deep invagination on the axial plate which is lined on its ventral margin by a row of long setae; tibial armature consists of a dorsal comb of three blunt teeth, one more apicad, a bifurcated ventral tooth and a row of spines on the dorsal comb; tarsus bimerous, 1st tarsomere with three backwardly directed spines. Midleg coxa wider than long 5:8; femur 8:7; tibia (Fig. 15) with 6-10 spines on the plate dorsally and 10 spines around the apex; tarsus pentamerous, tarsomeres with a row of 5 to 6 spines at their apices and in the length ratio 11:7:7:6:15. Hindleg coxa 6:5; femur broad at the base; tibia (Fig. 16) with 4 blunt teeth at the apex, 3 on the antiaxial plate and the remaining axially, and 12-14 spines on the dorsal plate; tarsus pentamerous; 1st tarsomere has two spines on its plate and all tarsomeres have a row of long spines at their apex; tarsal ratio 10:7:6:6:10.

Gaster: Normal

Host: *Ficus krishnae* C.DC.

Material Examined: Female holotype, INDIA: Kerala, Trichur (Museum Compound), coll. D.R. Priyadarsanan, 10.xii.1993, 2 female paratype and allotype 2 males. Slide mounted (Nos. ZDC A-XII/1, 1a, 1b, A-XII/2, 2a respectively).

Note: This species is related to *Eupristina (E.) belgaumensis* Joseph (1954), the pollinator of *Ficus glomerata* Thunb. var. *pubescens* (Roth.) Corner. However, these species differ in the following characters: In the female, *E. rehmani* has 5 ventral ridges on the mandibles, appendage has 10 lamellae, dorso-axial comb of foretibia has 3 claws, the hindcoxa has a circlet of setae around and ovipositor valves are twice the gaster, while *E. belgaumensis* has 6 ventral ridges to the mandible, appendage with 8 lamellae, 5 teeth to the dorso-axial comb of foretibia; hindcoxa is devoid of circlet of setae and ovipositor valves are only 1.7 times the gaster. In the males of *E. rehmani,* head is 1.33

times its width and foretibia has 3 teeth on the dorsal comb, while in *E. belgaumensis* the head is as long as wide and foretibia has 6 teeth on its dorsal comb.

Taxonomic position of *Ficus krishnae* C.DC.

Prain (1906) pointed out that *F. krishnae* shares many features with *F. benghalensis* L. and Corner (1965) treated it as a variety of *F. benghalensis* L. Studying the unique features of the development of its back-pocketed leaf, Unnikrishnan and Hema (1990) recommended revision of Prain's opinion.

In a mutualistic co-evolution, the phylogenic relationship of each partner must be congruent with the relative phylogeny of the other (Brooks 1985). A comparison of the classification of *Ficus* and the fig insects reveals that barring a few exceptions (Wiebes 1968, Compton 1990, Berg and Wiebes 1992) fig insects are species-specific, and related *Ficus* spp. have related pollinator wasps (Wiebes 1963, 1994; Wiebes and Abdurahiman 1980). So no wasp can propagate its kind or effect pollination in any plant except its specific host.

Ficus benghalensis is pollinated by *E. masoni* Saunders (1883). The presence of a pollinator species of its own, i.e. *Eupristina (E.) rehmani,* prevents the chances of *Ficus krishnae* being cross pollinated with *F. benghalensis.* This favours the view that independent species status must be accorded to *Ficus krishnae.*

Etymology: The new species is named after Dr. U.C. Abdurahiman, Professor of Zoology, University of Calicut, in honour of his contribution to our knowledge of fig insects.

ACKNOWLEDGEMENTS

I thank the Head of the Department of Zoology, University of Calicut, Kerala for providing necessary facilities and Dr. U.C. Abdurahiman, Professor of Zoology, University of Calicut, for inspiration.

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■ ■ ■

A NEW SPECIES OF *SERICUS* ESCHSCHOLTZ (COLEOPTERA: ELATERIDAE: LUDIINAE) FROM INDIA[1]

PUNAM GARG AND V. VASU[2]

(*With four text-figures*)

Key words: New species, *Sericus* Eschscholtz, Elateridae, India.

Sericus bicarinatus sp. nov. is described and illustrated. The features distinguishing it from its allied species *S. lahaulensis* Vats and Chauhan have been commented upon.

INTRODUCTION

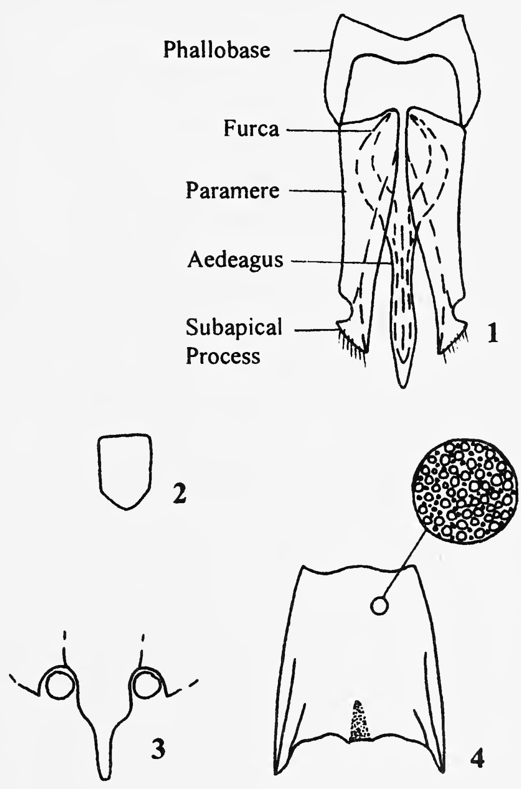
Genus *Sericus* Eschscholtz is characterized by having frons broader than long; labrum entire, mandibles dentate; prothorax broader than long, posterior margin with lateral furrows; prosternopleural sutures simple, parallel; elytra with rounded extremities; aedeagus longer than parameres and parameres with subapical processes. With the discovery of a new species from Himachal Pradesh, Vats and Chauhan (1992) recorded *Sericus* for the first time from India. To this genus, we are adding a new species which has been recorded from Nagaland (India). Though this species was collected from the leaves of *Bambusa* sp., the host plant is uncertain.

Type material will be deposited at Indian Agricultural Research Institute, Division of Entomology, Pusa National Collection, New Delhi, India.

Sericus bicarinatus sp. nov.
(Figs. 1-4)

Colour: Body piceous; antenna and legs fuscoferruginous.

Measurements: Body length 11.5 mm, width 2.5 mm; head length 1.25 mm, width 1 mm; antenna 5.5 mm; second segment 0.15 mm; third segment 0.3 mm; fourth segment 0.5 mm; last segment 0.6 mm; thorax length 2.25 mm, width 2.5 mm; elytra 7.75 mm.



Figs. 1-4: *Sericus bicarinatus* sp. nov.:
1. Male genitalia; 2. Scutellum; 3. Prosternal spine; 4. Pronotum.

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External features: Body width less than 0.25x its length. Head flat, longer than broad as 5:4; frons with incomplete frontal carina; antenna extending beyond posterior angle of pronotum; segment 3 longer than 2 as 6:3 but shorter than 4 as 3:5; mandible dentate. Pronotum convex, broader than long as 10:9, gradually narrowing anteriorly (Fig. 4); posterior angle rounded, bicarinate, outer carina reaching middle of pronotum, inner carina short; prosternal spine pointed, without any medial glabrous line, declined from its main axis at 25°, emarginate, abruptly narrowing at base (Fig. 3). Scutellum flat, longer than broad as 3:2, anterior margin straight, posterior margin arcuate (Fig. 2). Elytra convex, 3.44x prothorax length; striae distinct. Metabasitarsus longer than following 2 joints combined as 8:7.

Sculpture: Head with simple, dense, large, hexagonal punctation; pronotum (Fig. 4) with double, dense, rounded punctation; propleurae with simple, dense, oval punctation; prosternum with simple, scattered, rounded punctation; elytral striae with deep, distinct, oval punctation; interstriae with scattered, fine, inconspicuous punctation.

Pubescence: Body covered with moderate, slanting, brownish red pubescence.

Male genitalia: (Fig. 1) Phallobase with anterior margin emarginate; parameres with subapical processes with deep concavity behind; aedeagus longer than parameres, constricted in middle, with conical apex; furcae short, not reaching anterior margins of parameres.

Material examined: *Holotype*: Male, Nagaland, Zunheboto, 1874 m, 10.v.1994, under light Coll. Punam. *Paratypes*: 1 male and 2 females with same data as holotype.

Distribution: INDIA: Nagaland.

Diagnostic combinations: Characters distinguishing this species from its allied species *S. lahaulensis* are: posterior angles bicarinate (unicarinate in latter), antennal segment 3 shorter than 4 (longer in latter), pronotum with double, dense punctation (simple, sparse in latter) and prosternal spine with medial longitudinal glabrous line (without line in latter).

Etymology: The species name pertains to two carinae present on posterior angles of prothorax.

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We are highly thankful to Prof. L.K. Vats, Chairman, Department of Zoology, Kurukshetra University, Kurukshetra for his valuable suggestions and permission to compare our material with identified specimens. Financial assistance rendered by DST, New Delhi is also acknowledged.

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A NEW CYPRINID FISH OF THE GENUS *SALMOSTOMA* (SWAINSON) FROM A TROPICAL RESERVOIR OF SOUTH INDIA[1]

E.G. Jayaraj[2], D.S. Krishna Rao,[3] S. Ravichandra Reddy,[3]
Katre Shakuntala[3] and K.V. Devaraj[4]

(*With one text-figure*)

Key words: *Salmostoma belachi,* cyprinid fish, taxonomy

A new fish species of the genus *Salmostoma* from a tropical reservoir of South India is described. A total of 14 species of *Salmostoma* are reported to occur in Indian waters. The new species described hereunder stands separate from all the hitherto described species. 10 meristic and 19 non-meristic characters have been measured and compared with those of known species to establish its distinct taxonomic status.

Introduction

A new fish species of the genus *Salmostoma* (Family: Cyprinidae; Subfamily: Cultrinae) inhabiting the Nelligudda reservoir, 35 km from Bangalore, South India is described. While surveying for ichthyofauna of the Nelligudda reservoir, well established populations of *Salmostoma* hitherto undescribed were recorded.

The genus *Salmostoma* was established by Swainson (1839) with *Cyprinus bacaila* Hamilton as the designated type. While revising this genus, Banarescu (1968) clarified the generic status of *Salmostoma vis-a-vis Chela* Hamilton and *Securicula* Gunther. Following Banarescu, Jayaram (1981) listed 10 species occurring in Indian waters. Recently, Srithar and Jayaram (1990) have described a new species, *Salmostoma longicauda*, from river Krishna of Dhom reservoir. Talwar and Jhingran (1991) have taxonomically listed 14 species occurring in Indian waters. The new species described here stands significantly different from the hitherto known species of *Salmostoma* of Indian waters.

Ten specimens of the new species of either sex have been examined. The data on 10 meristic and 19 non-meristic characters were recorded and are presented in Table 1.

Salmostoma belachi sp. nov.

D II, 7; P I, 12; V I, 8; A III, 13 or 14; C 17 + 12; LL 86-89.

Diagnosis: A *Salmostoma* species with gill raker counts of 22-24, branched anal fin rays 13 or 14, and lateral line scale counts of 86-89 (see Table 2).

Description: Body compressed and elongated with minute scales. Dorsal profile nearly straight and round transversely. Ventral profile tapering and razor-like. Mouth upturned; symphysial knob on lower jaw fitting right into upper jaw groove; no barbels. Lips thin, snout plain. Eyes placed superiorly in the anterior part of the head, visible from below the ventral surface of the head. Pectoral fins laterally inserted, with prolonged outer rays. Pelvic fins short, not reaching the anal fin. Anal fin long, not reaching the caudal fin when depressed. Gill rakers few,

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TABLE 1
MORPHOMETRIC DATA OF *SALMOSTOMA BELACHI* SP. NOV. (N = 10)

Measurements	% Standard length			% Head length		
	Range	$\bar{x}$	SD	Range	$\bar{x}$	SD
Head length	20.24-24.41	22.30	1.31			
Pre-dorsal distance	58.02-64.88	63.00	2.25			
Pre-pelvic distance	48.33-53.49	50.70	1.95			
Pre-anal distance	66.38-70.69	68.84	1.17			
Distance from pectoral origin to pelvic origin	26.73-31.62	28.85	1.67			
Distance from pelvic origin to anal origin	18.40-20.58	19.66	0.78			
Distance from pectoral base to anus (length of body cavity)	45.15-50.00	46.62	1.61			
Length of caudal peduncle	15.34-18.02	16.38	0.80	65.34-84.85	73.30	5.66
Height of caudal peduncle	06.22-08.14	07.29	0.53	30.20-36.97	32.70	1.80
Body depth	16.53-20.00	17.79	1.01	74.87-87.27	79.88	4.30
Width of head				38.09-43.63	42.04	1.79
Height at occiput				63.20-68.65	66.89	2.00
Snout length				21.07-25.74	25.34	1.49
Width of mouth				20.47-28.71	24.24	2.74
Eye diameter				22.77-26.73	25.08	1.28
Inter-orbital width				22.70-28.71	24.82	1.56

Total length (mm) : 95.00-129.50 ($\bar{x}$ 110.30 ± 9.30); Fork length (mm): 85.00-106.00 ($\bar{x}$ 96.40 ± 6.50)
Standard length (mm) : 81.50-98.00 ($\bar{x}$ 88.70 ± 5.00); Head length (mm): 16.50-21.20 ($\bar{x}$ 19.80 ± 1.40)

TABLE 2
TAXONOMIC FEATURES OF *SALMOSTOMA* SPECIES COMPARED WITH *S. BELACHI* SP. NOV. (FROM TALWAR AND JHINGRAN 1991)

Name of the species	LL scales	Branched anal fin rays	Gill rakers on first arch
S. acinaces (Val.)	42-46	14-17	12-22
S. bacaila (Ham.-Buch.)	86-110	10-13	17-21
S. boopis (Day)	39-42	12-14	15-20
S. clupeoides (Bloch)	78-93	11-12	24-29
S. horai (Silas)	76-85	15	17 or 18
S. kardahiensis Reddiah	±52	12	42-52
S. novacula (Val.)	79-95	14-17	76-94
S. orissaensis Banarescu	76-89	18-19	13
S. phulo (Ham.-Buch.)	99-112	17-19	13-16
S. punjabensis (Day)	82-92	14-16	17 or 18
S. sardinella (Val.)	47-53	16-19	15-22
S. sladoni (Day)	61-68	18-19	15-17
S. untrachi (Day)	59-63	14-15	15 or 16
*S. longicauda**	51-70	13-16	58-76
S. belachi sp. nov.	86-89	13 or 14	22-24

* Srithar & Jayaram (1990)

22-24 in the first gill arch and moderately long. Lateral line curved towards the ventral profile, reaching the base of the caudal fin. Caudal fin forked, unequal, with lower lobe longer than the upper one (Fig. 1).

Scale counts:
LL / Dorsal........................15½
LL / Pelvic........................2½ or 3½
LL / Anal..........................3½ or 4½
Circumpeduncular..................25 or 27

Colour: Fresh specimens are bright silvery, with metallic green over the dorsal profile, while

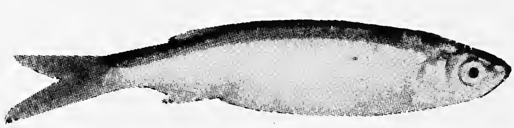

Fig. 1: *Salmostoma belachi* holotype (semi-diagrammatic)

formalin preserved specimens have a streak of grey running along the centre of the body and over the dorsal ridge; pale white below the lateral line.

Distribution: Nelligudda reservoir, Bidadi, Ramnagara Taluk, Bangalore dist., Karnataka, South India. Nelligudda reservoir is a perennial man-made lake constructed below the confluence of two seasonal streams, with a waterspread area of 80 ha at full reservoir level. The major fishery is contributed by the exotic cichlid *Oreochromis mossambicus*. *Salmostoma* are underexploited and occasionally appear in the catch when small meshed gillnets (30 mm approx.) are operated in the open waters. On an average, the fish attains a length of 110 mm and weighs 5.5 g.

Etymology: The new species is named after the popular name *Belachi* meaning blanched, indicating the apparent colour of the species in vernacular (Kannada).

The type specimens of *S. belachi* are deposited at the Zoological Survey of India, Chennai (Madras), and also at the Zoological Museum of Department of Zoology, Bangalore University, Bangalore.

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A NEW SPECIES OF *USCANA* GIRAULT (TRICHOGRAMMATIDAE: HYMENOPTERA) FROM THE EGGS OF *CONICOBRUCHUS ALBOPUBENS* (PIC)[1]

H.R. Pajni and Seema Sood[2]

(*With ten text-figures and two plates*)

Key words: *Uscana femoralis, Conicobruchus albopubens,* pest, *Cyamopsis psoraloides*

A new species, *Uscana femoralis,* is being reported from the eggs of *Conicobruchus albopubens* (Pic), a pest of *Cyamopsis psoraloides* DC (Hindi=*guar*). A key to the known Indian species of the genus *Uscana* is also given.

Introduction

Trichogrammatidae, including the well known *Trichogramma* associated with many pest species, is a family exclusively of egg parasitoids on a variety of insects. *Uscana,* another genus of Trichogrammatidae described by Girault (1911), includes 16 species which are mostly associated with the eggs of different species of Bruchidae (Viggiani 1979, Fursov 1987, Huis *et. al.* 1991). From India, only one species namely *Uscana mukerjii* (Mani) has so far been recorded from the eggs of store bruchids (Mani 1935: reported as *Chaetostricha mukerjii*). The taxonomy of genus *Uscana* is quite complicated and different species are recognized from the number of sensilla present on different segments of the antennal club. On this basis, Steffan (1954) divided the species under *Uscana* into three groups. *Uscana mukerjii* was subsequently allocated to a fourth group (Pajni and Singh 1973).

The species under report is exceptional in having greatly swollen hind femora in the male, a feature not observed in any of the known species.

Observations

The family Trichogrammatidae can be distinguished from other families of superfamily Chalcidoidea by the presence of 3-segmented tarsi. Genus *Uscana* can be separated from the other genera of Trichogrammatidae by a combination of characters namely: Antenna with one or two annulets, and placoid and fungoid sensilla on the 4-segmented club; broad forewing with straight and thickened marginal vein and a row of setae on RS_1 from tip to stigma (Dout and Viggiani 1968).

Key to the species of Genus *Uscana*

Male with hind femora normal ...... *mukerjii* (Mani).
Male with hind femora swollen ..... *femoralis,* sp. n.

Uscana femoralis sp. nov.
(Figs. 1, 6-14; Plate 1, 2)

Description

Female: Length 0.46-0.56 mm. Body short, flat, with ovipositor turned upward and forward in dry specimens; head light brown with face, front and vertex pale yellow; ocelli dark red; pronotum dark brown; mesoscutum pale yellow with two large brown patches; metanotum pale yellow; tibia and tarsi with apices pale white.

Head wider than thorax; mandibles quadridentate. Antenna with basal segment slightly widened in middle; pedicel 1.3 times as long as wide; annulets two, normal. Club 2.6 times as long as its greatest width at first segment, approximately equal in length to antennal

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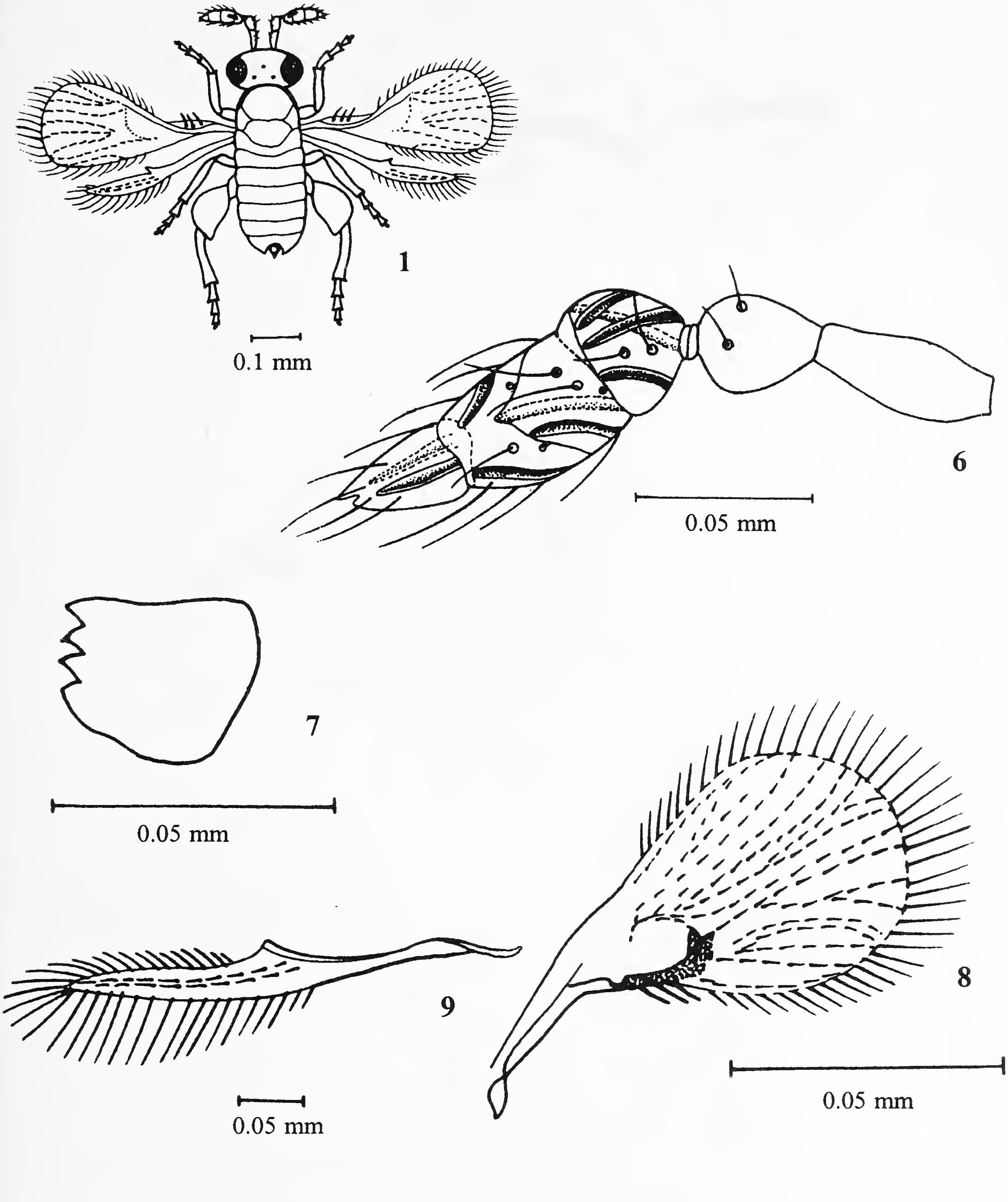
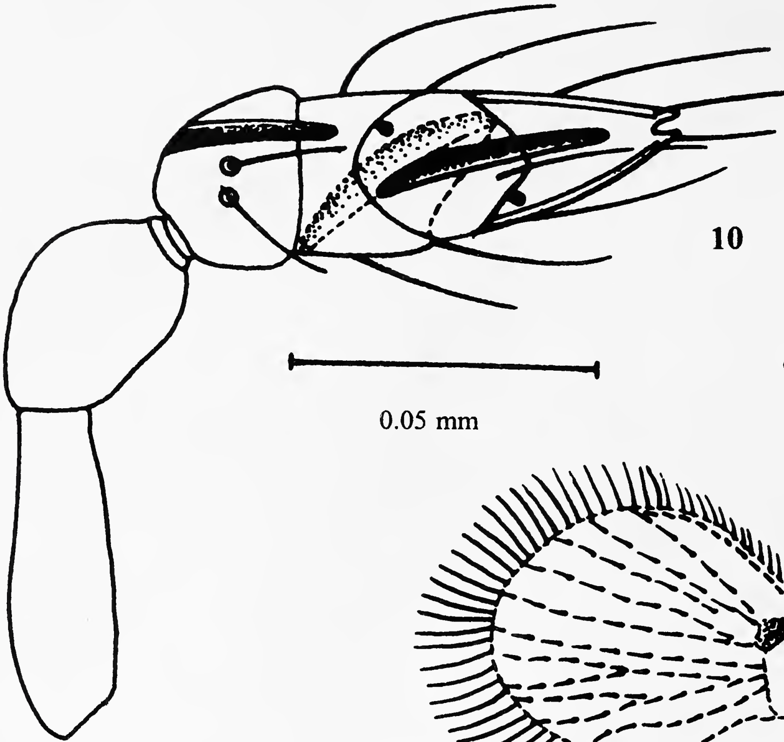


Fig. 1: *Uscana femoralis* sp. n., ♂; Figs. 6-9: *Uscana femoralis* sp. n., ♀: 6. antenna; 7. mandible; 8. forewing; 9. hindwing.



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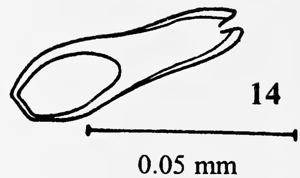

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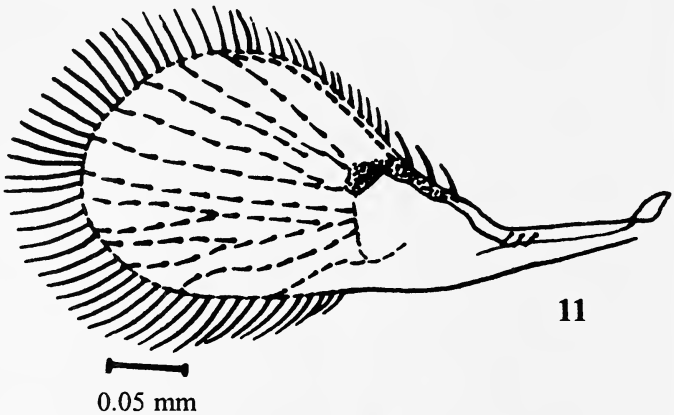

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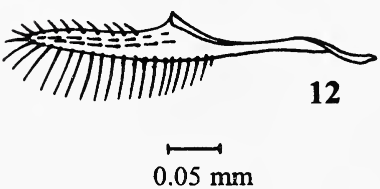

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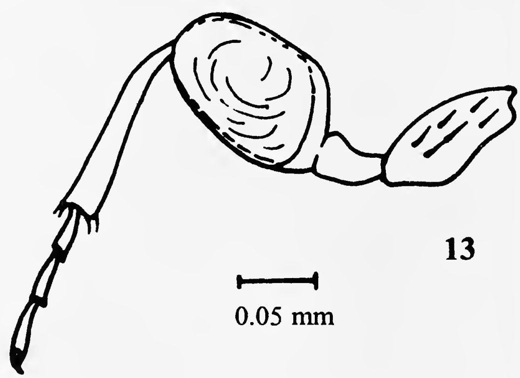

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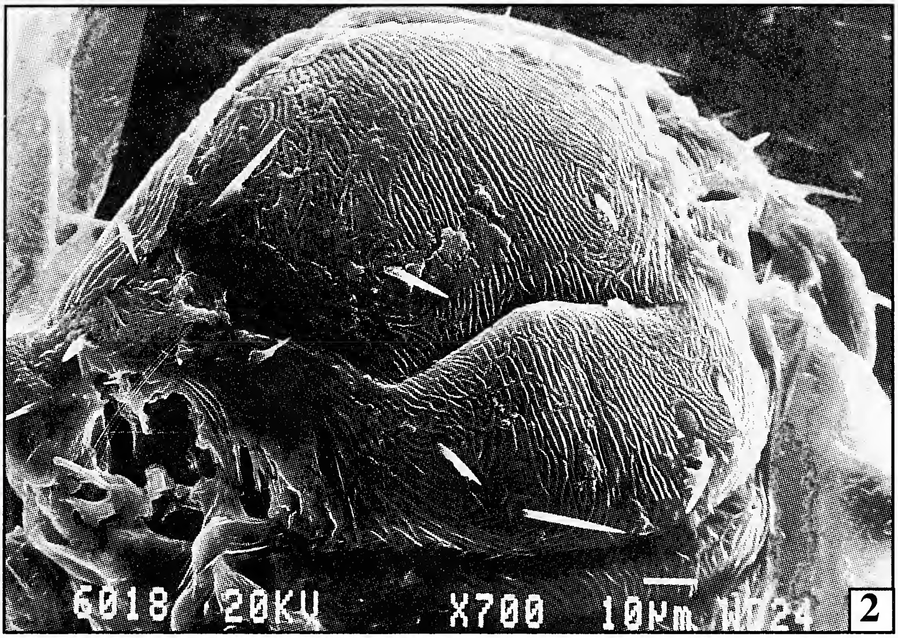
Figs. 10-14: *Uscana femoralis* sp. n., ♂; 10. antenna; 11. forewing; 12. hindwing; 13. hindleg; 14. genitalia.

Pajni H.R. & Sood S.: *Uscana femoralis* PLATE 1



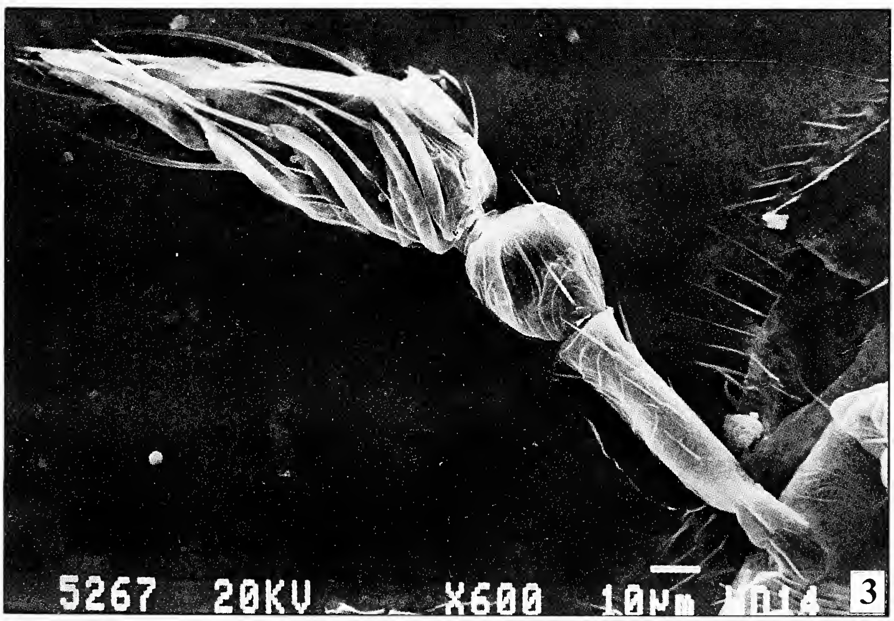
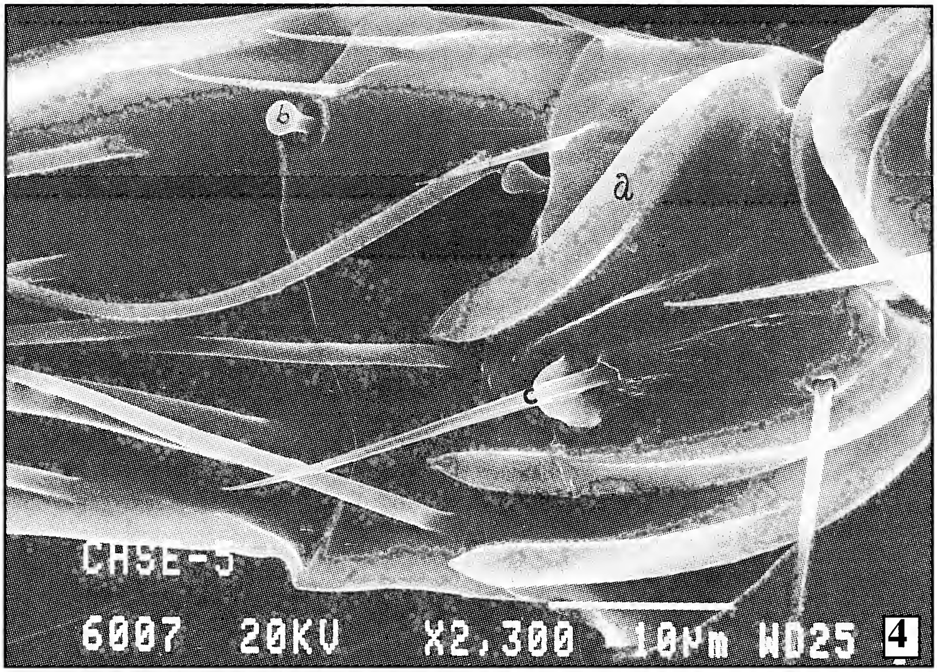


Fig. 2 & 3: *Uscana femoralis* Male: 2. Mesonotum; 3. Antenna.

Pajni H.R. & Sood S.: *Uscana femoralis* PLATE 2



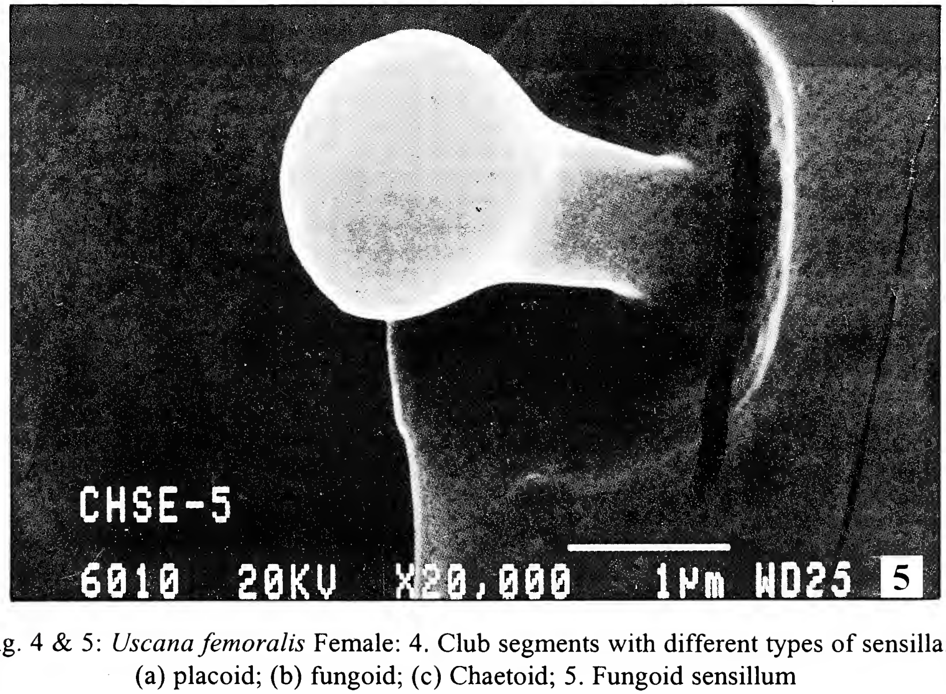


Fig. 4 & 5: *Uscana femoralis* Female: 4. Club segments with different types of sensilla; (a) placoid; (b) fungoid; (c) Chaetoid; 5. Fungoid sensillum

segments 3 and 4 together, with obtuse triangular projection on dorsal surface of first segment and a similar projection on one side of third segment, with fourth segment pointed apically, with sides of first segment 1.6 times as long as second segment and half as long as segment 3 and 4 combined. Club segments with following distribution of sensilla: placoid 4:2:2:2, fungoid 1:2:1:0, chaetoid 2:4:6:4, with longest sensilla (chaetoid) 1.4 times as long as greatest width of club.

Mesoscutum 1.6 times as wide as long, with an anterior pair of long and posterior pair of short setae; mesoscutal surface coarsely reticulate laterally and with a stripe of longitudinal reticulation in middle covering one fifth its area; scapula and axilla with single seta each; scutellum 1.9 times as wide as long, with an anterior pair of short and posterior pair of long setae, with coarse reticulation on sides and longitudinal reticulation in the middle. Postphragma reaching the abdominal tergite IV, a little shorter than length of mesonotum.

Forewing twice as long as its greatest width and its fringe one-fifth as long as its greatest width; costal cell 1.7 times as long as marginal vein; marginal vein 2.4 times as long as wide, furnished with 3 costal setae, 6 short hairs on dorsal side and 3 short hairs on ventral side; radial vein four fifths the length of marginal vein. Surface of forewing with 16 rows of discal setulae, 13 of them running uniformly. Hindwing about 8 times as long as its greatest width, its fringe 1.5 times as long as greatest width of free membrane.

Abdomen 1.69 times as long as thorax; ovipositor protruding, approximately equal to length of midtibia (16:14.5).

Male: Length 0.39 - 0.51 mm. Pedicel 1.5 times as long as wide; annulets 2; club 2.9 to 3.0 times as long as its greatest width at first segment and 1.5 times as long as segments 1 and 2 combined, first and third segments equal, second and third subequal, segment 1 slightly reduced on inside and prolonged on outside, segment 2 with incurved sides and projecting upper surface, segment 4 bifid at tip; sensilla of club with following distribution: placoid 1:1:1:0; fungoid 1:1:1:1; chaetoid 3:3:2:5.

Forewing 2.3 times as long as its greatest width, its fringe one third of its greatest width; surface of forewing with discal setulae arranged in 17 rows, with 13 of them uniform. Hindwing about 7 times the greatest width of free membrane. Hind femur strongly broadened, dark brown; male genitalia with phallobase 3.0 times as long as broad.

Material: *Holotype* Male; from eggs of *Conicobruchus albopubens* (Pic) on the pods of *Cyamopsis psoraloides* DC (*guar*); Coll. Seema Sood, 23.ix.1995; Chandigarh. *Paratypes* 8 males, 4 females; collection data same as for the holotype. Type material in Entomology section, Department of Zoology, Panjab University, Chandigarh. Regn. No. 135/99.

Distribution: Areas surrounding Chandigarh.

Biology: A parasitoid of eggs of *Conicobruchus albopubens* (Pic), which is a pest of *Cyamopsis psoraloides* DC (Hindi = *guar*). Under laboratory conditions, it also attacks the eggs of *Callosobruchus maculatus* (Fabr.), *C. analis* (Fabr.), *C. chinensis* (Linn.) and *Zabrotes subfasciatus* (Boh.).

Etymology: The species has been named after the characteristic greatly swollen hind femora of the male.

ACKNOWLEDGEMENTS

We thank the University Grants Commission for financing a project on biological control of bruchids, and the Chairman, Department of Zoology, for providing research facilities.

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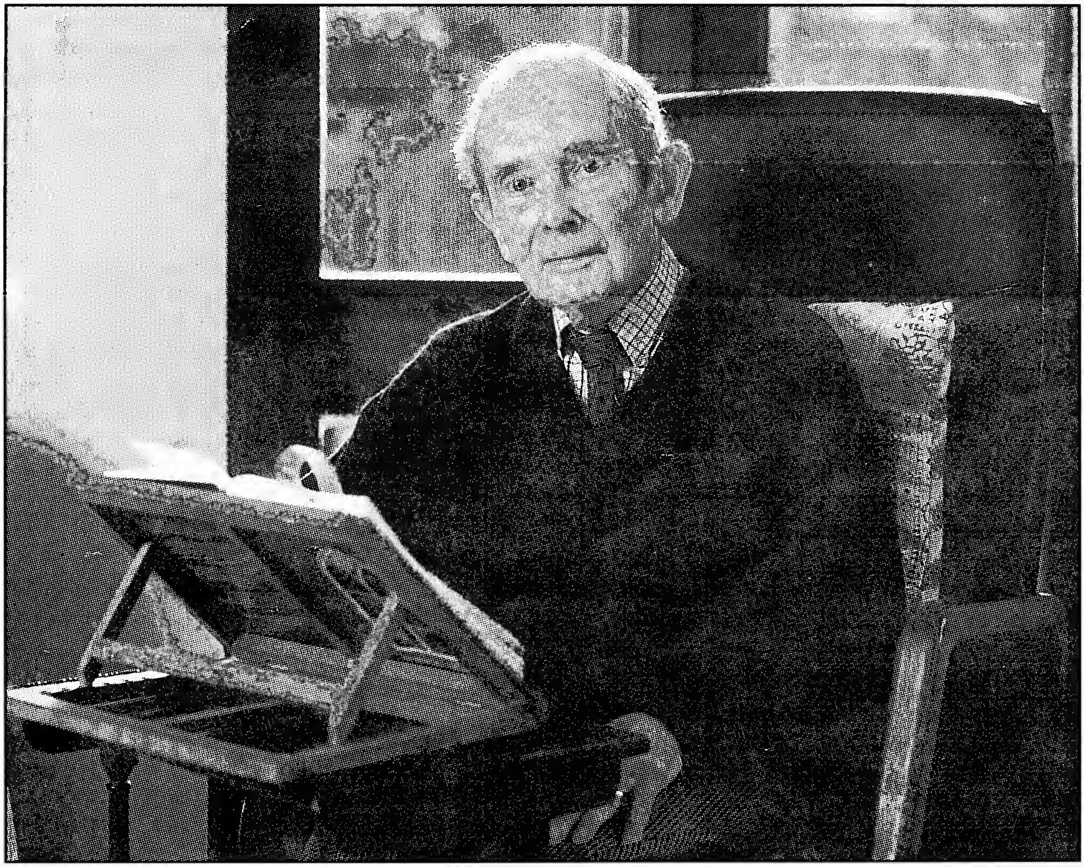

Mr. Cyril Edward Hewetson
OBE IFS (Retd)
1903 - 1998

OBITUARY

Cyril Edward Hewetson

OBE IFS (Retd)

CEH was born in 1903. His father served in India in the Indian Civil Service and his maternal grandfather in the Indian Medical Service. He remained in India as a small child until his father retired when CEH was four years old.

He was educated at Repton, King's College, London, and Oxford University where he studied Forestry, and gained a Blue in Hockey.

He joined the Indian Forest Service and went out to the Central Provinces in 1926, serving in Balaghat, Nagpur, Raipur, Bastar, Berar, Bhandara, North Chanda, Jabalpur, Betul and Hoshangabad. At the time of Independence, in 1947, he was one of only two British Forest Officers left in the C.P., the other being Archie Stein. CEH stayed on, and eventually took over from G.G. Takle as Chief Conservator, Madhya Pradesh for a short period before he retired from India in 1955.

He was a keen member of the Bombay Natural History Society, writing observations on the bird life in Madhya Pradesh, which were published in 1956 and other articles later on in the journal of the BNHS. He became a Life Member in 1963.

After his retirement, he continued his interest in forestry and wildlife both in India and in his home country. He was a member of the Royal Forestry Society, the Commonwealth Forestry Society, and the Society of Foresters, attending their meetings well into his eighties.

In the last two decades, he made several visits to India, and attended the centenary celebrations of the Society in 1983. Sálim Ali also visited him in England. He maintained a keen interest in all the Society's activities until his death on July 15, 1998, at the age of 95.

CEH was married in 1954 and is survived by his wife and two sons.

A LIST OF HIS PUBLICATIONS IS GIVEN BELOW:

Hewetson, C. E. (1939): The bird year in Betul (Central Provinces). *JBNHS 41*: 286-310.

Hewetson, C.E. (1944): Additional notes on the birds in Betul district and surrounding area in the Central Provinces. *JBNHS 44*: 471-474.

Hewetson, C.E. (1944): Bearded Bee-eater (*Alcermerops athertoni*) in the Central Proinces. *JBNHS 44*: 592-593.

Hewetson, C.E. (1954): Migration of insectivorous birds in Madhya Pradesh in 1953. *JBNHS 52*: 207-208.

Hewetson, C.E. (1956): Observations on the bird life in Madhya Pradesh. *JBNHS 53*: 595-645.

Hewetson, C.E. (1981): Madhya Pradesh forests revisited. *JBNHS 78*: 333-336.

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REVIEWS

1. REMINISCENCES OF INDIAN WILDLIFE by R. S. Dharmakumarsinhji. 1998. pp115. Published by Oxford University Press, Delhi. Rs. 225/-.

R. S. Dharmakumarsinhji, the youngest of three brothers of the last ruling Maharaja of Bhavnagar State in Gujarat, was perhaps the finest example of the class of hunter-naturalists, who contributed immensely to documenting the saga of India's wildlife. During a career spanning six decades, Dharmakumarsinhji authored four books and more than a hundred articles. Some of the articles are classical and compulsory reading for young Indian naturalists. They are written in the old, rambling style, but they help in comparing the wildlife situation then and now.

REMINISCENCES OF INDIAN WILDLIFE is a delightful book, small but full of interesting observations made by the author during his hunting expeditions, and later during natural history forays. The book was written as early as 1971, and published 12 years after the author's death, Mr. Divyabhanusinh has done an excellent job by writing a brief biography of Dharmakumarsinhji. The book contains 14 chapters, generally very interesting to read, even though some of them have gory details of slaughter of wildlife. I did not like the first chapter *Crocodile Anecdotes*, as it is full of grisly descriptions of killing peacefully sleeping or resting crocodiles. The book is also full of the terms 'game', 'sport', 'shooting', which may have been prevalent 50 years ago but now, when Indian wildlife is facing its worst crises, they appear outdated. Despite the antediluvian approach, the book is absorbing to read and shows the keen interest of the author in natural history details. For example, the mating behaviour of lions is wonderfully described. In this book, replete with shikar stories, it was a delight to read the amusing description of cooperative behaviour of the large grey babbler. Dharmakumarsinhji is perhaps the first naturalist to observe a crude tool-using attempt by these perky birds.

Unfortunately, the selection of pictures is not good. Most of them are very dark and badly printed. Many were taken in captivity. Sometimes, the caption does not make sense, e.g. "I received reports of a man-eating tiger" under a picture of an over-fed tiger in some zoo. Only two pictures have been acknowledged (p 93 and p 97), so ostensibly the remaining pictures were taken by the author. However, the picture on page 47, of a tusker in the rains is a well-known photograph by Mr. M.Y. Ghorpade.

■ ASAD R. RAHMANI

2. ENVIRONMENT AND ORNITHOLOGY IN INDIA by Prakash Gole. 1994. Published by Rawat Publications, Jaipur and New Delhi. pp 262 (22.1 x 14.4 cm) Price Rs. 400/-.

This compact book has an attractive jacket with the famous wildlife artist David Rankin's paintings of a foraging pair of sarus cranes and a painted stork.

The book's fifteen chapters are based on the author's work of over fifteen years on ornithology and the environment. He is one of the best known crane conservationists in the country and it is quite natural that he has devoted four full chapters to cranes. The last chapter is on the barheaded goose, a spin-off from his studies on blacknecked cranes. The rest are mainly on his studies in and around Pune, where he lives.

Gole has discussed serious environmental issues such as regional environment planning, restoration of the forest cover on the hills, ecological and social dynamics of an irrigation reservoir and managing man-made wetlands. In simple, easy to understand language, he has

offered practical solutions to such vexatious issues as managing bird sanctuaries or man-made tropical wetlands.

The chapters on birds in the urban environment, in agriculture and in polluted rivers, reveal the author's deep understanding of the functioning of ecosystems, based on his painstaking observations.

The chapters on the blacknecked and sarus cranes, and barheaded goose are good. The reader is taken to the beautiful and remote valleys of Ladakh, Arunachal Pradesh and Bhutan, and also to the fertile Indogangetic plains where the sarus and man co-exist. In lucid style, he discusses the problems and threats faced by these bird populations. He has successfully developed a habitat suitability index for various species. It was interesting to read where he discovered the blacknecked crane in Sangti Valley (Chapter 14, page 240). He could actually predict the presence of the cranes based on the habitat suitability index and the presence of the benign Buddhist community.

The author's narrative style, though interesting and informative, tends to become very boring and redundant at times. The first chapter is replete with details about the formation of the Panchgani Regional Planning Board and its subcommittees, whereas very little is said about how the environmentalists succeeded in persuading the Board to accept their demands of preserving the ecology of the region.

The recommendations for attracting birds or creating habitats for some species appear to be very simplistic and based on inadequate data. The preference and utilization of water depths, food and roosting habitats could only be obtained by many years of systematic observations or from published work carried out on the species elsewhere. The author has assigned birds to various groups, based on their feeding in different depths of water or roosting in particular habitat, without referring to his data or any other published information (p 59). At times, the grouping does not make sense, e.g. according to feeding habits, and the groups are birds of prey, upland feeders and grassland feeders. The classification should be insectivorous, piscivorous, granivorous birds. According to habitat it should be upland feeders, grassland feeders and wetland feeders. While discussing management plans for bird sanctuaries or suggesting measures to attract more birds, literature should have been consulted exhaustively. There have been a number of species-specific and bird community studies in India on the habitat utilization and food preferences of many species, which could have been consulted.

There is inconsistency in the usage of bird names. In chapter 15, mostly latin names are mentioned. The barheaded goose is referred to as *Anser indicus* but at one or two places only the common name has been used. It is difficult to make out from the text that the latin name of the barheaded goose is *Anser indicus*. In Chapter 6, only common names are used, whereas in Chapters 13 and 14 both common and latin names are used. In running text only common names should be used, while latin and common names should be given in an appendix to avoid confusion.

There are inconsistencies in the names of places also. The Keoladeo National Park is mentioned as Bharatpur Bird Sanctuary (p 254), and Keoladeo Ghana National Park (p 79). Editing is not up to the mark and there are spelling mistakes even in the tables (p 64).

Despite these shortcomings, the book makes good reading and is a must for any good library of natural history. On the whole, it is informative and it will interest serious ornithologists as well as amateurs.

■ VIBHU PRAKASH

3. COMMUNITY FOREST MANAGEMENT IN PROTECTED AREAS.

© Rural Litigation & Entitlement Kendra (RLEK), Dehradun, 1977. pp v + 336 (15 cm x 20.7 cm). Hardbound Edition, published by Natraj Publishers. Dehradun, 10 maps, 9 appendices, 19 tables, photographs. Rs. 395/-.

This book is a good case study of a forest dependent community and incorporates the field work done by the Rural Litigation Entitlement Kendra (RLEK) in the Rajaji National Park.

The book documents in detail the conflict between the Van Gujjars, an indigenous forest-dwelling pastoral tribe in northern Uttar Pradesh and the authorities responsible for the proposed Rajaji National Park. It outlines an alternative management plan by providing a general model of Community Forest Management in Protected Areas and specific proposals for implementation in the proposed Park. The appendices contain the *World of the Van Gujjars*, an account of their benign outlook and lifestyles, the *Rio Declaration on Environment and Development, ILO Convention 169 of 1989*, and *National Forest Policy* (1988). The exhaustive references provided by the researchers put the issue in its proper context. The Rio Declaration, the ILO Convention, to which India is a signatory, and the National Forest Policy (1988), acknowledge the rights of forest dependent communities.

The concept of Community Forest Management in Protected Areas (CFM - PA) where the community takes the lead and manages the resource while the government is a passive supporter or observer, as drawn up by RLEK in consultation with the Van Gujjars, aims to protect the Rajaji National Park as well as the traditional rights of the local villagers and the nomadic Van Gujjars.

Realisation is now dawning on professionals and amateurs alike, that the task of nature conservation is inexorably spinning out of hand. It is now acknowledged that, 'Nature can never be managed well unless people closest to it are involved in its management and a healthy relationship is established between nature, society and culture'. Practical, realistic and down to earth, the Van Gujjars possess an intimate knowledge of wildlife and the forest. Their cultural values and a feeling for the forest are still largely intact and speak strongly against poaching or destruction of habitat. These very sentiments and attitudes, the protagonists argue, can be channelised to help conserve the Rajaji ecosystem. The objectives are sought to be met through five complementary strategies.

Though well intentioned, the proposals leave quite a few queries unanswered. In a few years from now, will the educated offspring of these Van Gujjars prefer the nomadic lifestyle of their parents and continue to be a part of the CFM system? The reviewer is witness to similar changes in lifestyle in Jammu & Kashmir, where the government's aggressive education policy has brought education to the doorstep of the remotest pastoral communities. The dramatic change in lifestyles has in turn affected, to quote just one example, the production of mutton. Livestock for this has to be imported from outside the state, for what used to be a livestock surplus state!

The protagonists realise the magnitude of the change in management practices that the CFM system entails and plan to implement it in pilot zones so as to identify strengths and learn from problems as the process evolves. Yet they appear to be over ambitious when anticipating cooperation from others, naively suggesting 'prompt prosecution' of persons who threaten or harass the Van Gujjars in the course of implementing the programme.

At first glance the idea appears utopian. Will it attract cooperation and commitment from the 'dispossessed' forest officials as before? What about the Police, the Revenue department and other officials? On close scrutiny, the arguments

for the CFM sound convincing. The CFM plan seeks to circumvent the trauma of forceful eviction that the Van Gujjars otherwise face. Hence on this count atleast, the plan should be given a trial.

The book highlights the population trends in the area and points out that the Van Gujjars have been unjustifiably accused of breeding like rabbits. The Van Gujjar population has shown a marginal increase from approximately 3072 in 1931 to about 5500 at present, while the population of Dehradun district has multiplied roughly four times between 1941 and 1991. Moreover, the needs of the Gujjars pale into insignificance when compared to the unrelenting and unsustainable demands of the urbanised population of Dehradun district.

The ecological and economic exploitative system that the Van Gujjars encounter in their daily lives has been well documented and should serve as an eye opener. Ironically, inspite of all the harassment and exploitation that they are subjected to, the unlettered Van Gujjars stand accused, like the proverbial lamb drinking downstream accused of having spoiled the water upstream!

■ S. ASAD AKHTAR

4. SURVIVAL STRATEGIES — COOPERATION AND CONFLICT IN ANIMAL SOCIETIES by Raghavendra Gadagkar. Pp i-xvi + 1-196, (21 x 15 cm), Published by Universities Press (India) Ltd. 1997. Paperback price Rs. 120/-.

In the words of E.O. Wilson, "SURVIVAL STRATEGIES is a highly readable update of the spectacular evolutionary productions of animal behaviour. The author, a leading contributor to the subject, ranges smoothly from natural history to the genetic basis of the many phenomena that have surfaced in the past two decades."

Professor Raghavendra Gadagkar draws upon a vast storehouse of information on social behaviour in animals, particularly his own field of specialisation, i.e. insects, to write an eminently interesting book. He has illustrated his ideas with well known and some lesser known examples, including cooperation in the social organisation of honey bees, evolution of melanistic forms in *Biston betularia* (Lepidoptera), bird migration and the conflicts between the queen and workers in social ants.

The author has not only addressed many questions which would interest students of evolution, behaviour and genetics, but has also provided the interested, inquiring mind with a great deal of information, free of jargon or pedantry. A gem from page 9: "When the food reserves of the (honeybee) colony fall to dangerously low levels, the workers seize the drones by their legs and throw them out of the colony!"

The author has followed the maxim quoted at the beginning of the Preface "Nothing in biology makes sense except in the light of evolution." He says "Variety and diversity are the hallmarks of biological systems and ... there are many different ways that animals have developed for achieving a given objective." He concludes at the end of the book "Whatever the extent of variation, however, we can be certain that achieving a fine balance between cooperation and conflict is an invariant feature of the survival strategies of social animals."

Finally, a word about the production values. The Universities Press (India) Ltd. has brought out a series of Educational Monographs, of which this book is one. To this reviewer, accustomed to ploughing through page after page of indifferent prose, a skillfully written, competently edited and well printed book is a pleasure to read.

■ GAYATRI UGRA

MISCELLANEOUS NOTES

1. THE DESERT CAT *FELIS LYBICA* IN PANNA NATIONAL PARK

I saw a desert cat in Panna National Park on the evening of October 25,1997. It was near the southeastern corner of the Park, about 500 m west of Rampura barrier. When I first saw it from about 50 m, it was crouching by the side of the road, probably stalking the jungle bush quails that were dust bathing close by. When I approached it on my motorcycle, it stood up on its longish legs, swiftly climbed the rubble boundary wall and jumped on to the other side. I stopped the motorcycle, turned the engine off and rolled it back. The cat froze, and watched me passing by. It was about the size of an adult domestic cat, but more slender and with a long tail. It was pale sandy buff overall, cryptically merging with the background terrain. It had slightly elliptical black spots on the flanks and almost all over; two thick black stripes on the elbows; a black ringed tail; black stripe on the cheeks and with small triangular ears. Its tail length was about two-thirds the size of the body.

Prater (1965) gives the distribution of the desert cat in India as Gujarat, Rajasthan and the arid regions of central India. Its extralimital distribution extends from Africa into middle-east Asia. However, the recent classifications consider *Felis lybica* a subspecies of the widely distributed *Felis sylvestris* (Corbett and Hill 1992). Jerdon (1874) and Brander (1982) write about having collected specimens of this cat from places like Nagpur, Mhow, etc., in central India. However, there are no records as far east as Panna, though the habitat in Panna is quite similar to the western semi-arid parts of central India.

October 27, 1998

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2. STATUS OF THE WILD WATER BUFFALO *BUBALUS ARNEE* IN LOHIT DISTRICT, ARUNACHAL PRADESH

(*With one text-figure*)

With the decline of its wild population, and due to its restricted range, the Asiatic wild water buffalo *Bubalus arnee* Kerr is in urgent need of conservation attention. Micro-level information has becomes extremely important. Here I report its occurrence and present status in the Lohit dist. (27° 35'-28° 28' N, 95° 46'-97° 25' E) of eastern Arunachal Pradesh. Field studies have been carried out in the area between 1992 and 1994.

Reference to the wild buffalo in this area is found in Cooper (1873), after which no published records were available till Choudhury (1996). However, I documented the status of the species in Dibang Valley dist., which is adjacent to Lohit (Choudhury 1988). An account of its status in northeast India, the only stronghold of

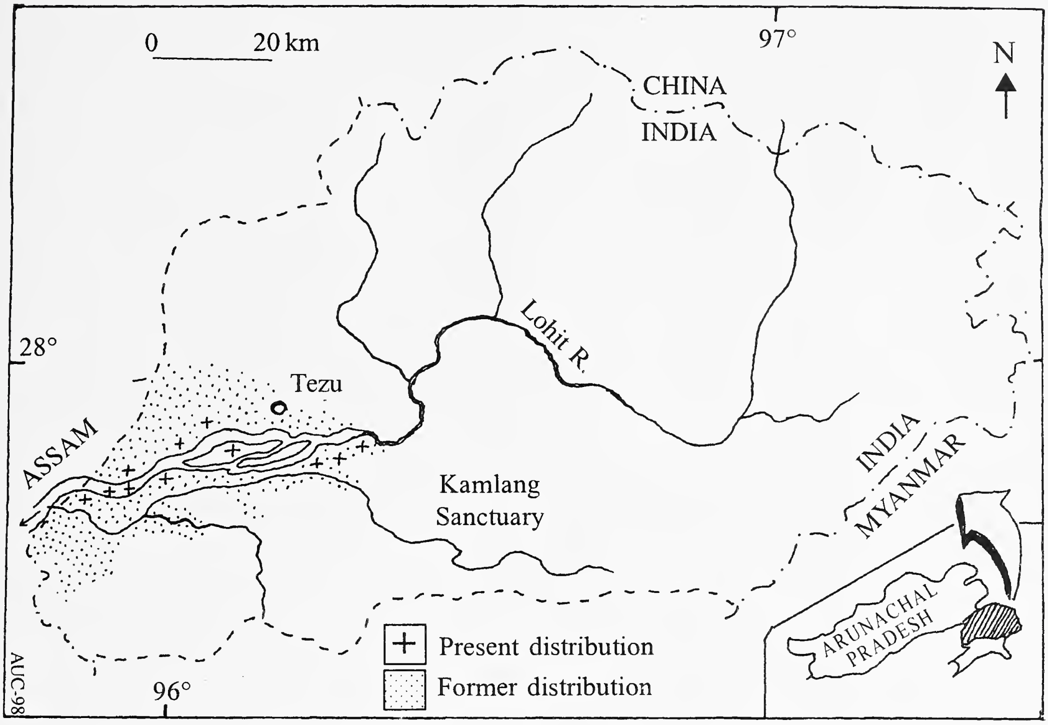

Fig. 1: Distribution of wild buffalo in Lohit district.

the species, was given (Choudhury 1994). Katti *et al.* (1990) mistook horns of domestic animals preserved at Kalai basti in Kamlang Wildlife Sanctuary which were brought for sacrifice, for those of the wild buffalo.

From the habitat type and discussion with old hunters, villagers and forest staff, it seems that the wild buffalo was not uncommon in the riverine tracts of the Lohit river, from Parshuramkund (Brahmakund) where the river debouches onto the plains, to the interstate border with Assam near Sunpura in Sadiya, and then extending inside Assam. The grassy tracts of some of the tributaries of the Lohit, such as Hajjo and Digaru rivers, were also inhabited by the buffalo. The last large herds in the Hajjo river area were seen in the early 1970s.

At present, small and scattered populations occur in the *chapories* (riverine islets and tracts) of the Lohit river, with stray animals in Hajjo and Digaru *chapories*. In 1986, one bull was shot near the Lohit river, near Wakro after it had killed a Nepali grazier. In the same area, a herd of 20 was seen in 1995 (M. Kashyap, pers. comm.). In September, 1993 a lone bull was encountered by the forest staff in Lai Anchal Reserved Forest (RF). The animals are shy because of fear of hunting. Although they do not occur inside the Kamlang Sanctuary, some animals roam in the northern areas of Kamlang RF.

Estimating the population of such an extremely shy (due to regular persecution) and thinly distributed species is a difficult task. However, after visiting all the known and potential areas and interviewing old hunters and graziers of the *khutis* (cattle camps, mostly run by Nepalis and Biharis), villagers and forest staff, it can be safely said that there are less than 20 animals in Lai Anchal RF and adjacent areas, mostly affecting the grasslands of the Lohit river.

In the grasslands between Wakro and Chowkham, covering parts of Turung, and northwestern areas of Kamlang RF and adjacent grasslands on the banks of the Lohit and Kamlang rivers, some 60 to 90 buffaloes occur. Between Chowkham and Sunpura, covering parts of Lohit, Paya and Digaru RFs including the adjacent unclassed forests, a widely scattered population of 20 to 40 animals occurs. Westwards, it is contiguous with some of the buffalo-bearing areas of Bhim *chapori* of Sadiya in Tinsukia dist. (Assam). The total habitat available for wild buffalo in the district is around 150 sq. km. (Fig. 1).

Expansion of lowland paddy cultivation by the Khamtee tribe in the southern areas of the Lohit river, poaching for meat by the Khamtees, Digaru Mishmi and Miju Mishmi tribals, development of townships at Tezu, Chowkham and Wakro and shifting of many interior villages to the fertile plains have resulted in a gradual decline of the wild buffalo. Moreover, the presence of domestic buffaloes in the *khutis* is a potential hazard to the small wild population due to the danger of diseases like anthrax, foot-and-mouth and rinderpest. However, domestic males are usually not kept in the *khutis* and hence, contamination of wild stock due to interbreeding is a remote possibility. Domestic animals going feral are also brought back immediately, because they are too valuable to their owner. The feral animals are also shot by the local tribals for food.

Poaching with guns and rifles is taking its toll, and unless conservation measures are taken, the future of these animals in Lohit dist. is bleak. The grassy parts of Kamlang RF, Lai Anchal RF and some adjacent areas (totalling about 30 sq. km) have been recommended as additions to the Kamlang Wildlife Sanctuary.

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3. DAYTIME RESTING IN THE NEST — AN ADAPTATION BY THE INDIAN GIANT SQUIRREL *RATUFA INDICA* TO AVOID PREDATION

Predation may play an important role in influencing social behaviour. In tree squirrels, predation could affect nest tree selection and behavioural strategies. Most studies on temperate and tropical squirrels have documented the importance of diurnal raptors as predators of sciurids. (Emmons 1980, Borges 1989, Joshua 1992).

Predation attempts by the black eagle (*Ictinaetus malayensis perniger*) and crested serpent eagle (*Spilornis cheela*) on the Indian giant squirrel (*Ratufa indica*) and grizzled giant squirrel (*R. macroura*) have been reported by Borges (1989), Ramachandran (1991), Joshua (1992), and Joshua and Johnsingh (1994). I observed three unsuccessful predation attempts by the crested hawk-eagle (*Spizaetus cirrhatus limnaetus*) on the Indian giant squirrel (*Ratufa indica*) in Bori Wildlife Sanctuary (WLS), Madhya Pradesh (Datta 1993).

Squirrels were observed in two riverine patches surrounded by deciduous forests. One of these, along Bhainsa *nullah* was subject to disturbance due to nearby villages and cattle grazing. Canopy gaps exist in this forest due to felling of trees in the past. The other study site was a relatively undisturbed riparian habitat.

Observations were made while following five individually identified squirrels twice a month from dawn to dusk, using focal animal sampling (Altmann 1974) from December 1992 to April 1993. Two other individuals were also observed for 2 days each in December.

After the morning feeding bout, giant squirrels usually return to their nest tree to rest. The nest seems to be the focal point to which they return after foraging. Squirrels rested inside the nest in the afternoons, both in summer and winter. They rarely rested for long periods in the canopy. A large part of the day was spent inactively inside the nest. Previously, nests were reported to be used extensively in the daytime only in the wet season and also at mid-day during the dry season (Borges 1989). I found that the squirrels usually returned to the nest or adjacent trees after foraging in the morning. A squirrel which is resting for long periods in the afternoon outside the nest can be extremely vulnerable to avian predators which were seen frequently in the relatively shady, cool riparian area. These raptors were active in the afternoon, calling and flying through the canopy, and perching on the tall *Terminalia arjuna* trees. A squirrel resting outside would have to be alert because of greater chances of predation, whereas inside the nest it would be safer. Resting inside the nest in the daytime could thus be an adaptive strategy to avoid predation. In fact, a predation attempt was seen when an individual squirrel came out of the nest in the afternoon, to rest outside. The individual I was following was safe inside the nest and could not be detected by raptors. The two raptor species sighted here are not reported to be nest robbers, unlike the black eagle (Joshua and Johnsingh 1994).

Based on my observations and anecdotal evidence, I hypothesize that giant squirrels, irrespective of sex or even season rested inside the nest as an anti-predatory strategy. It is not unusual for temperate squirrels to rest inside the nest in the winter months because of the harsh sub-zero temperatures. But tropical squirrels have not been reported to enter the nest in the daytime except during heavy rains or inclement weather (Borges 1989, Joshua 1992). Borges (1989) reported that they used the nest for resting at mid-day in the dry season, attributing it to facilitation of heat loss in summer. But this was not a regular occurrence in her study area.They usually rested on horizontal broad branches in the canopy after their morning forage and rarely entered the nest except to feed young or in very bad weather (Borges 1989). In any case, if the squirrels were resting inside the nest due to weather conditions, they would not be doing so both in summer and winter (December 1992 to April 1993). Therefore, it is unlikely that it is thermoregulatory behaviour. This behaviour was observed for all focal squirrels. This could be a local adaptation to a disturbed habitat, where the canopy is more open and where there seems to be a high density of two raptor species which prey on giant squirrels. Emmons (1980) speculated that by retiring to the nest early, a squirrel could minimise its daily exposure to diurnal avian predators.

Nevertheless, towards the end of my study in April, on the last two days, the individuals I followed did not retire to the nest but rested in the lower canopy which was still leafy and shaded. Since it was summer, the nests were exposed to the sun in the top canopy of the nest trees at the edge of the riparian area. Therefore, at certain times, unfavourable nest temperature may prevent the squirrels from resting in the nest.

Raptors were sighted at least once on every observation day, frequently between 1000 h and 1430 h, though in winter they were twice recorded around 0640 h. A nest of the crested-hawk eagle was sighted further up the *nullah* on

in secondary forests, verges, clearings, scattered woodlands and plantations. They are not birds of the primary forest interior (Thiollay and Meyburg 1988). They perch in tall trees using them as lookouts to scan for prey, reportedly jungle fowl, peafowl, partridges, hares, rodents, snakes and lizards. I observed a hawk-eagle preying on a field or bush rat in the late afternoon. On another occasion, I observed for close to an hour a hawk-eagle feeding on an unidentified prey.

Predation rates have been reported higher close to the forest edge, suggesting that predation rate was high due to predators living in the surrounding habitat and penetrating the forest fragments (Wilcove 1985, Wilcove *et al.* 1986). The relative abundance of raptorial species was found to increase in disturbed and logged forests (Johns 1983).

The general behaviour pattern observed in all focal squirrels, and incidentally in other non-focal squirrels entering the nest in the daytime to rest for long periods, may constitute a local adaptation to a more disturbed, open canopy habitat, where avian predator density, activity and predation attempts seem high.

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4. REDISCOVERY OF THE AFGHAN MOLE VOLE *ELLOBIUS FUSCOCAPILLUS* IN PAKISTAN

(*With one plate*)

Rodents which spend most of their lives underground are hard to catch or trap, and hence are poorly represented in the world's major museum reference collections.

Roberts T.J.: *Ellobius fuscocapillus* PLATE 1

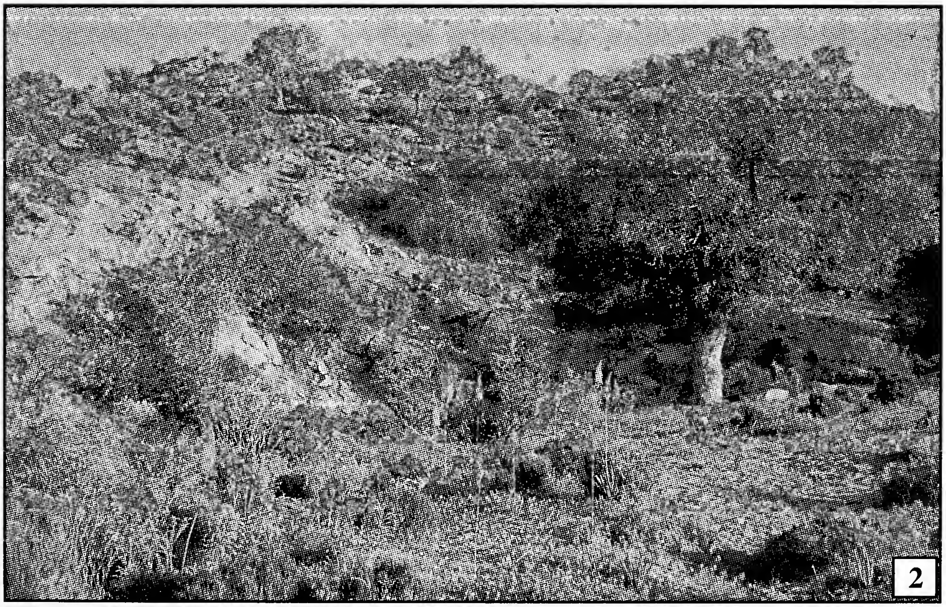

Fig. 1: *Ellobius fuscocapillus* showing incisor teeth; Fig. 2: Habitat of *Ellobius fuscocapillus* showing foxtail lilies and mountain ash *Fraxinus xanthoxiloides*

Whilst studying the mammals of Pakistan in the 1970's, I examined specimens available in the British Museum of Natural History, the Smithsonian Natural History Museum in Washington, and the extensive collection belonging to the Bombay Natural History Society, which has received contributions from all over the Subcontinent. The Smithsonian possessed a good series of the Afghan mole vole (*Ellobius fuscocapillus*) from northern parts of Iran, but none from Pakistan, or elsewhere, despite extensive mammal collecting in the province of Baluchistan during the 1960's by the University of Maryland, and later by the Chicago Field Museum in neighbouring Afghanistan. The British Museum possessed only two specimens from Pakistan, and one from Afghanistan, both Pakistani specimens collected at the turn of the century, from Mach in the centre of the province (29° 52' N, 67° 20' E). There were no specimens in the Bombay Natural History Society collection.

In the late 1960s and throughout the 1970s I made mammal trapping surveys in most parts of Baluchistan. My associates working for the FAO sponsored Vertebrate Pest Control Centre (of which I was then Project Manager) under the National Agricultural Research Council of Pakistan, also searched around Mach, only encountering the short tailed mole rat (*Nesokia indica*), so that I concluded (Roberts 1977) that this larger and highly aggressive burrowing rodent had possibly driven the Afghan Mole Vole, at best a relict population in Pakistan, to local extinction.

In 1995 my friend S. Raza Abbas, a professional wildlife photographer was perched on a precipitous mountain ridge in the Torghar Range of Zhob dist. in northwestern Baluchistan, filming straight-horned markhor (*Capra falconeri jerdoni*). Something moving by his feet caught his eye — it was a very active, small, furry creature which seemed to ignore human presence, and was busily searching for green food. Raza Abbas filmed it eating green leaves and moving extensively over very steep shaley ground. Some two years later, this film was shown to Dr Charles Wood of Florida Museum and subsequently to me —both of us recognised it with excitement as the long lost Afghan mole vole — excitement because it was discovered nearly 322 km northwest of the Mach (at 31° 20' N, 68° 27' E), at a much higher elevation (2650 m) and in a region which experiences winter temperatures down to -16°C. The literature, mostly from Russian sources, described this vole as inhabiting rolling hilly country and preferring valley floors with a good covering of soil. In the former Soviet Union, it only occurs in southern Turkmenistan along the border with northeastern Afghanistan (Bobrinskii *et al.* 1965).

In late April this year, I had the privilege of camping in the Torghar Nature Reserve, in Zhob dist., Baluchistan, at the invitation of Sirdar Naseer Tareen, a local tribal leader who is a dedicated conservationist and who through patience and persistence has encouraged the local tribesmen to create this Sanctuary, successfully controlling over-grazing and banning all hunting. (Sadly, such success stories are exceptional in Pakistan today). From this experience, I would like to add to what is known about this enigmatic little vole. The habitat can be described as arid mountain steppe country, with light snowfall in winter not exceeding 45 cm. Torghar consits of jagged wind-eroded sandstone and mudstone ranges, extending roughly east-west for approximately 96 km with rainfall rarely exceeding 101-121 mm per annum.

The region is characterised by much endemism in plants, and in spring is decorated with stretches of bright flowering plants, including many bulbous lilies, tulips and wild onions. These succulent bulbs form the main diet of the Afghan mole vole, principally the golden foxtail lily, *Eremurus stenophyllus,* the Persian foxtail lily *Eremurus persicus,* pink or yellow *Tulipa stellata,* and several species of *Allium.*

The dominant trees are stunted xerophytic *Pistachio cabulica* and *Fraxinus xanthoxiloides*, interspersed with bushes of *Berberis balochistanica* and *Astragalus psilocentris*.

Evidence obtained over five nights, from recently excavated mounds of earth, indicated that the mole vole was relatively widespread and common in this area, from 1,800 - 2,600 m. A mature specimen is quite large for a vole, measuring 140 mm in head and body length, with a very short, hair-covered tail 11-15 mm in length, tiny eyes, a blunt upturned muzzle, and very prominent pro-odont incisors, pinkish white in colour and bearing longitudinal grooves. The body fur is velvety and thick, enabling the animal to reverse inside its burrow when necessary. The tiny ears are hairless and hidden in the body fur (2-5 mm in length). Its scientific name (*fuscocapillus*) indicates that the hair of its head is blackish, but the body fur can be quite variable in colour, generally quite dark in winter, changing to reddish or cinnamon brown in summer, but with most of the head blackish and the cheeks paler reddish brown. The belly fur is greyish white, and the forefeet, considering its burrowing habits are not particularly strong or well developed.

Captured animals, as well as free ranging ones, often showed no inclination to burrow, and Lay (1967) describes one in Iran which swam strongly across a 9 m wide stream, and another which travelled 300 m, and remained one hour above ground before commencing to burrow. Their eyesight is, however, very poor as indicated by the one which nearly bumped into Raza Abbas, and also by their frequent falling off the edge of eroded ground whilst travelling on the surface. Their burrowing technique is not entirely typical of other fossorial rodents, in that they use mostly their protruding incisors to dig soil, only occasionally pushing it backwards with the forefeet, and eventually moving their whole body backwards, using their spade shaped hind feet to push soil into surface mounds. After admiring the speed with which this vole could burrow in such dry stony ground, I would like to "christen" it "Fossorulus" (Latin = Little Digger). When its jaws are open the fur covered lips are seen to extend around and behind the incisors down to a relatively small round mouth opening. Such an arrangement enables them to dig and to forage, without swallowing any soil. Films made by S. Raza Abbas and Sirdar Tareen show the area with plenty of small predators, including the stone marten (*Martes foina*), the elusive spotted steppe cat (*Felis sylvestris ornata*), hill foxes (*Vulpes vulpes griffithi*), rat snake (*Ptyas mucosus*), and such diurnal birds of prey as the booted eagle (*Hieraaetus pennatus*), and both the long legged (*Buteo rufinus*) and common buzzard (*Buteo buteo japonicus*). The Afghan mole vole must at times fall prey to all these, but it does not hibernate in winter and can breed at all times of the year (Nowak 1991), and so can reproduce fairly rapidly. Grzimek (1975) states that they reach sexual maturity at 90 days and that the young are fairly slow growing, remaining in the underground nest for upto 8 weeks.

On April 28, 1998, at an elevation of 2285 m, with the help of the local tribesmen I obtained an immature female (head and body length 123 mm), with a litter of three young estimated as one month old. These were light silvery grey in colour with black face masks, quite unlike their cinnamon brown mother. The nest was a surprisingly bulky affair made of chewed herb and grass fibres, and measuring about 220 cm in diameter. Tunnels radiated from this nest.

This vole has an ability to reconnoitre new territory and to travel extensively above ground, frequently in bright sunlight and over very steep gradients. In Torghar there is only sparse vegetative cover with much bare ground intervening, and being dependent mostly on underground tubers, this vole must soon exhaust accessible food supply and seek fresh ground in which to burrow. The much more widely spread short tailed mole vole (*Nesokia indica*), in Baluchistan is confined to areas with some grass cover. Our radio telemetry studies in Sind (Fulk,

Smiet, and Khokhar 1981), revealed that *Nesokia* spends prolonged periods underground, surfacing only occasionally, invariably in darkness. Its principal food, we found, was rhizomes of grasses and succulent roots. It is, therefore, not an ecological competitor with *Ellobius* in arid mountainous tracts.

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5. *MENOPON GALLINAE* INFESTING GREATER ADJUTANT STORK *LEPTOPTILOS DUBIUS* AT NAGAON, ASSAM

Numerous reports on the occurrence of the poultry louse *Menopon gallinae* on poultry and wild birds are available (Soulsby 1968) but there appears to be no report on the occurrence of *M. gallinae* on the greater adjutant stork *Leptoptilos dubius* (Gmelin). The greater adjutant stork is the most endangered species of stork in the world (Rahmani *et. al.* 1990). Only a small viable population is surviving in the Brahmaputra valley, Assam (Saikia and Bhattacharjee 1989). These storks are mainly scavengers, but during the breeding season they prey on living creatures. In the non-breeding season, they are found at garbage dumps in some towns of Assam. At such foraging sites they can be seen with vultures *Gyps* spp., black kites *Milvus migrans,* crows *Corvus* spp. and other scavengers. The garbage generally contains inedible parts of slaughtered animals, which are readily eaten up by adjutant storks.

In 1995 in Nagaon, a juvenile greater adjutant stork was observed sitting continuously on a mound in a shallow river for more than 24 hours. It was too weak to walk and fell down frequently when it tried to walk. We brought it to our field laboratory for study and to render first aid.

The bird was seen to be heavily infested with tiny, flat, mobile, wingless arthropods. They were removed with a soft brush and preserved in glass vials for identification. They were cleared in 10% KOH solution, fixed in 10% formalin and permanent slides were prepared. At the College of Veterinary Science, Assam Agricultural University, Guwahati, they were identified as the common poultry louse *Menopon gallinae.*

The infested bird was treated first with a repellent extract of deodar and vegetable oils. Later, it was treated with Carbaryl Dust Notix (Carbaryl 5%, Inerts q.s.). Within ten days, the lice had almost disappeared.

After we gave it medicine for liver disease and drops of astrozyme, it recovered quickly and became a voracious feeder. Soon it could stand on its feet, and on the third day it had almost recovered. We kept it for two months under observation and then released it into the wild.

Menopon gallinae (Family Menoponidae, Order Mallophaga) is a well known insect ectoparasite (Noble and Noble 1974). It is pale yellow in colour. The male is 1.71 mm and the female 2.04 mm. The thoracic and abdominal segments each have a row of bristles. This species is found in all domestic and wild birds, including turkey, guineafowl, ducks and pigeons (Levine 1983). The eggs are laid in clusters on the host feathers and the life cycle is completed on the same host. The eggs hatch in two to three weeks. These lice are not blood ingesters, they feed on the barbs and scales of the host feathers. They do not infest young chicks, presumably because chicks lack well developed feathers (Cheng 1982).

In most birds, heavy infestation is generally encountered during winter. Birds affected by lice are restless because of the irritation. They become so restless that they cannot feed or sleep properly. Birds scratch their bodies to get rid of the lice and injure themselves, which leads to complications. The infestation apparently causes reduced egg production in birds, and increases the host's susceptibility to bacterial, viral and protozoal diseases.

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6. STRANGE DEATH OF A SHIKRA

Deep in the desert, southwest of Jaisalmer in Rajasthan, I was watching a shikra (*Accipiter badius*) flying very low over the sandy plain. Suddenly it gained height, dived to the ground, then flew up, with a rodent in its talons. Through the binoculars I could not identify the species of the small mammal. Having settled over an electric wire the shikra started feeding on the prey. While the raptor was feeding on the body of the rodent, the tail was dangling below. The bird shifted its posture and the rodent's tail touched the electric pole-bar below, there was a

flash and a spark, and the shikra dropped to the ground, dead. Apparently, through the rodent's tail, the body of the shikra was earthed, resulting in its death by electrocution. The predator had become a prey of man's electric power. Both the animals were collected. The rodent turned out to be an Indian desert gerbil, *Meriones hurrianae* (Jerdon).

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7. MYCOTOXICOSIS - A THREAT TO WINTERING CRANES IN SAURASHTRA, GUJARAT.

The Saurashtra region (21° 10' - 24° 45' N, lat.; 68° 10' - 70° 30' E long.) of Gujarat state, India, is the most important wintering ground for the demoiselle crane *Anthropoides virgo* and common crane *Grus grus*. Several hundred thousand cranes winter in this region. In the wintering ground, the cranes mainly feed on groundnut *Arachis hypogea*. Therefore, a research project on "Assessment of crop depredation by cranes in the groundnut cropfields" was carried out in collaboration with the Indian Council of Agricultural Research, New Delhi, for three years. Field study commenced in October, 1989 and during the study period we recorded 32 cranes with peculiar symptoms, which resulted in their mortality within 2-3 days. The symptoms observed were paralysis of wing and neck, reluctance to feed, weight loss and death within 2-3 days. Dein (1989) reported that there are four major factors, bacterial, fungal, viral and animal parasites, which affect cranes both in captivity and in the wild. The cranes were probably suffering from mycotoxicosis, caused by the fungus *Aspergillus flavus*, which produces a toxin called aflatoxin. The fungus is a normal constituent of the microflora in air, soil and water and is associated with living or dead plants and animals throughout the world. Aflatoxins are carcinogenic and mutagenic, and were implicated in an outbreak of hepatitis in tribal areas of more than 200 villages of Rajasthan and Gujarat in 1974. It was observed that groundnut and its products are a favourable substrate for the growth of *A. flavus*, when its moisture content exceeds 9% (ICAR Report 1987).

In Saurashtra, the groundnut crop is harvested during July and October. Hence, at the arrival time of the cranes, most of the harvested fields have left over groundnut pods. During winter, the moisture content of the soil and groundnut may increase, which favours the growth of *A. flavus*. Thus, mycotoxicosis reached a peak during January and February. Furthermore, during our study period we visited only 30% of the waterbodies of Saurashtra region, in which we recorded 32 diseased cranes. Hence, there are possibilities of more cranes with similar disease. The afflicted cranes are unable to move due to paralysis of their wings and legs, and fall easy prey to such predators as the village dog, fox and jackal.

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8. SIGHT RECORDS OF THE LITTLE GULL *LARUS MINUTUS* FROM GUJARAT

We saw a single little gull *Larus minutus* Pallas in flight amongst a mixed flock of gulls at Nalsarovar Bird Sanctuary (Ahmedabad dist.), on January 25, 1996. Since the foraging flock was very close, comparison of its size with other gulls through a spotting scope was not difficult.

The second record was made at Okha port (22° 15' N, 69° 01' E, Jamnagar dist.) on the Gulf of Kachchh on December 29, 1996. Four little gulls, along with the blackheaded gull *Larus ridibundus*, yellowlegged herring gull *Larus argentatus* and lesser blackbacked gull *Larus fuscus* (total 500 gulls) were sitting on the edge of a shallow water body at 1300 h.

The species has been reported from Shinay dam, Anjar tehsil, Kachchh (Bapat and Himmatsinhji 1992) and the coast of Bhavnagar (Parasharya *et al.* 1994). Present sight records suggest that the species might be far more common on the coast and freshwater bodies of Gujarat than it was believed to be, and it can be distinguished from other gulls using a good optical instrument.

May 8, 1997

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9. THREETOED KINGFISHER *CEYX ERITHACUS* SIGHTED AT PANARWA

Panarwa is a village situated about 100 km. southwest of Udaipur in Rajasthan. High hills of the Aravalli surround this village, which has an extensive forest area, one of the densest and largest forest tracts of Rajasthan. The River Vakal runs through this forest. Deep and shady pools of water remain all through the year at many places in the river in this region. The river course is strewn with boulders and the banks have dense vegetation. The area has been declared a Wildlife Sanctuary called "Phoolwari Ki Naal."

On April 20, 1997 at 1715 h as I was searching around some of the shady pools of Vakal river for aquatic birds, I sighted a kingfisher perched on a branch about 30 m from where I stood. The plumage of this bird took me by surprise as it was different from all the kingfishers found in this region. This prompted me to make a detailed note of its features with the help of my binoculars. The bird obliged me for about seven minutes and then flew away. When I compared its features with those in "HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN" by Sálim Ali and S. Dillon Ripley (1987) I found it to be an Indian three toed forest kingfisher (*Ceyx erithacus*).

The distribution of this bird is restricted to moist deciduous and evergreen biotope. Ali & Ripley's HANDBOOK says: "Resident, dispersing widely during the rainy season with the advent of suitable conditions. Thus, a regular SW monsoon (breeding) visitor to many areas, then

also turning up sporadically in unexpected localities. Movements not worked out. Nepal eastward through N. Bengal, Sikkim, Bhutan... Assam, Nagaland.... Also the humid Sahyadris or Western Ghats and their outliers from a little north of Bombay (limit not established)..." This first sighting of the bird in Rajasthan is of special interest.

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10. APARTMENT NEST OF THE PYGMY WOODPECKER *PICOIDES NANUS*

On February 2, 1992, I saw a pygmy woodpecker (*Picoides nanus*) excavating a fresh hole in a dead branch of a live *Bombax ceiba* tree at the Peechi-Vazhani Wildlife Sanctuary, Kerala. The nest-hole was being excavated on a branch about a metre long, that already had four other holes. This hole was the second and about 40 cm from the tip of the branch. The holes were more or less evenly spaced and were *ca* 15-20 cm from each other. All were of uniform dimension (3.3 cm diam) and hence were presumed to be earlier nest/roost cavities of the pygmy woodpecker. The branch was soft, its bark peeling off and hence preferred for nesting. Subsequently, the bird occupied the nest. The nesting was successful and two young ones were raised in due course.

Woodpeckers generally avoid nesting near old nests, as these may be known to potential predators and competitors (Nilsson *et al.* 1991; Sonerud 1985; Sedgwick and Knopf 1992). Besides, old nest substrates may be weakened by decay as smaller woodpeckers generally prefer weaker and softer substrates which, especially in tropics, may decay fast and be unsafe (Kilham 1983; Hagvar *et al.* 1990; Lang and Knight 1975). Yet the choice of this branch for nesting indicates a shortage of nest substrates for these birds, and calls for better forest management practices. This would ensure the availability of suitable branches for nesting.

Acknowledgement

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11. RANGE EXTENSION OF RUFOUSBELLIED BABBLER *DUMETIA HYPERYTHRA HYPERYTHRA* (FRANKLIN)

The Compact Handbook of the Birds of India and Pakistan by Sálim Ali and S.D. Ripley (1987) mentions the range of rufousbellied babbler *Dumetia hyperythra hyperythra* from Simla in

the north to Darjeeling, West Bengal and Bangladesh in the east, south to the Krishna river and west to a line passing through Hyderabad, Jalna, Mhow and Jhansi. The western limit of the range falls approximately on 78° E longitude and roughly overlaps with the distributional range of the Mount Abu whitethroated babbler *Dumetia h. abuensis* on 22° N lat. A CHECKLIST OF THE BIRDS OF ANDHRA PRADESH by Siraj Taher and A. Pittie (1989) lists *Dumetia h. hyperythra* as a very rare resident in Andhra Pradesh. According to Abdulali and Panday (1978, CHECKLIST OF THE BIRDS OF DELHI, AGRA AND BHARATPUR) the rufousbellied babbler has not been recorded from Bharatpur and only one sighting has been recorded from the Delhi area. Kota is an industrial centre in southeast Rajasthan on the banks of the Chambal river (25° 10' N lat., 75° 56' E long.). It is located in the intervening area where neither of the above-mentioned babblers are expected to be found.

We found the rufousbellied babbler in the margins of an old patch of forest at Jagpura, 15 km from Kota city, which was a hunting reserve of the erstwhile rulers of Kota. Although much depleted in size now, this area harboured large cats and a variety of ungulates in its heyday. On April 7, a party of 5 rufousbellied babblers was found among the clumps of bamboo growing on the southern margin of the forest. The area is interspersed with *Carissa, Annona, Acacia* and *Zizyphus* bushes. *Ficus, Bombax, Azadirachta, Tamarindus, Phoenix, Morinda, Terminalia* and *Mitragyna* form the upper canopy of the forest.

The upper body of these babblers is sandstone brown with a dull red crown from forehead to nape. The bill is horny grey, and legs and feet are pink. The lower body is the colour of red clay, with a greyish undertail. There is no white colour on the throat, or any other part of the body, except for a few white upperwing coverts visible only when the bird ruffles its feathers.

A party of five rufousbellied babblers *Dumetia h. hyperythra* was seen moving about in the bamboo thickets. The birds were identified on the basis of field characters, habits and habitat. Over a period of seven days, 8 to 10 hours were spent on observation. It is a very restless bird, always flitting from branch to branch, entering deep into the clumps and rarely coming out into the open. The group was seen feeding on insects, moths and flies. A full grown individual was seen begging for food by dropping its wings, tucking in its tail and chattering in typical babbler fashion. It was fed a white moth by another adult bird.

Although Ali and Ripley (1987) state that its habits and food are similar to the whitethroated babbler *Dumetia h. albogularis*, we observed that the rufousbellied babbler prefers bamboo clumps and thorny bushes, and rarely descends to the ground to rummage for food among the leaf litter. The party of four to five birds flies from thicket to thicket, and moves rapidly in the depths of vegetation in search of insects, many a times disappearing for 5-10 minutes. Suddenly, the birds come out into the open, fly a short distance, hop from branch to branch, regroup and plunge into the clumps of vegetation again.

All the literature consulted suggests that although it is widely distributed, this bird occurs in small and fragmented populations. The present record extends its westward range by approximately 300 km (78° E - 75° E long.) and its shared habitat with the Mount Abu whitethroated babbler by approximately 200 km (22° N - 25° N lat.). In view of its rarity, the rufousbellied babbler's range extension is extremely important.

We are thankful to Mr. A.H. Zaidi for his help during the surveys.

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12. SIGHTING OF WHITEBROWED BLUE FLYCATCHER *MUSCICAPA SUPERCILIARIS* IN SILENT VALLEY, KERALA

The whitebrowed blue flycatcher (*Muscicapa superciliaris*) is a small bird that breeds in the Western Himalayas between 1800 and 3200 m (Ali and Ripley 1987). Its breeding range extends from Kohat in Pakistan to the north-eastern hill states of Nagaland, Manipur, Assam, Meghalaya and Arunachal Pradesh in India.

The bird winters in central India, occupying areas from Delhi down to southeast Karnataka and northwest Andhra Pradesh, covering northern Maharashtra, Orissa, Bengal and Bihar (Ripley 1982, Ali and Ripley 1987). Recently, it has been sighted at Shareneshwar in Sabarkantha, Gujarat (Khacher 1996). This implies that there is no record of the bird migrating to the Western Ghats region. There is no report of its occuring further south than southeast Karnataka. It is not recorded so far from Kerala (Ali 1969, Ali and Ripley 1987, Neelakantan 1996, Neelakantan *et al.* 1993).

On March 5, 1997, while monitoring frugivorous birds in Silent Valley as part of a project on keystone species, a bird with striking colouring (blue upperparts with prominent white eyebrow extending to the nape and white underparts with prominent greyish band broken by white on the breast) was seen by the first author. The bird was sitting in the middle storey canopy of a *Mallotus philippensis* tree located in the ecotone region of an evergreen patch at Sirandhri in Silent Valley. It sat at a safe distance from a seemingly related species, the rufous tailed flycatcher (*Muscicapa ruficauda*), which is common in the area. It moved from branch to branch at the time of observation, possibly in search of insects. It was seen for only five minutes, and then it flew away. Later study confirmed the identity of the bird as a male whitebrowed blue flycatcher (*Muscicapa superciliaris*). This species was not sighted again in Silent Valley until May 1997.

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August 25, 1997

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13. BLACKNAPED BLUE FLYCATCHER *HYPOTHYMIS AZUREA* TRAPPED IN THE WEB OF THE GIANT WOOD SPIDER *NEPHILA MACULATA*

In October 1996, I had gone birdwatching to the Sanjay Gandhi National Park (SGNP) situated in Mumbai. I was observing a mixed hunting party of brown flycatcher *Muscicapa*

latirostris, redbreasted flycatcher *Muscicapa superciliaris*, blacknaped blue flycatcher *Hypothymis azurea* and paradise flycatcher *Terpsiphone paradisi*, when I noticed a vigorously vibrating web of the giant wood spider *Nephila maculata*, which was about 1.5 m in diameter.

I also saw a blacknaped blue flycatcher at a distance of 1 m from the centre of the web, where the spider was resting. On closer inspection, I realised that the left wing of the bird was entangled in one of the main spokes of the web. The bird was alive but exhausted, as all its desperate attempts to free itself proved futile.

The giant wood spider is the largest orb weaving spider in India (K. Vijaylakshmi and Preston Ahimaz, SPIDERS: AN INTRODUCTION, 1993) and is known to feed on large insects, but I am not aware whether birds also form a part of its diet. Moreover, it was surprising to see a bird weighing 9 - 14 gm, several times heavier than the spider, helplessly entangled in the web.

I have read about the bird eating spiders of the equatorial forests of South America, but to see a blacknaped blue flycatcher trapped in a web was a memorable experience. I waited at the spot for 45 minutes, but eventually had to leave due to bad weather.

June 27, 1997

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14. HOUSE SPARROW FEEDING ON TENDER LEAVES OF NEEM (*AZADIRACHTA INDICA*)

The house sparrow (*Passer domesticus indicus*), a common bird feeds on a variety of food items. THE HAND BOOK OF BIRDS OF INDIA AND PAKISTAN (Ali and Ripley 1987, 10: 670) describes the food of the species as mostly grass, weed seeds and cereal grains, also fruits and flower buds, tender shoots, kitchen scraps and insects.

On March 20, 1996, at my residence at Raipur, a female bird was seen plucking a fresh tender leaf from a neem tree (*Azadirachta indica*), carrying it to the ground below, holding it in the bill and placing it on the ground. In order to feed on it, the sparrow placed the leaf under its toe, snapped off a fragment and fed on it. This was repeated thrice and in the process half the leaf was eaten. Thereafter, the bird flew away, leaving the remaining part of the leaf on the ground.

Though the species is known to feed on tender shoots, feeding on a bitter leaf of the neem tree is reported for the first time.

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15. *CALOTES VERSICOLOR* FEEDING ON *LYCODON AULICUS*

According to Smith (1935), Daniel (1983) and Tikader and Sharma (1992), *Calotes versicolor* is primarily an insectivorous arboreal lizard, but also takes small birds and their nestlings, frogs, centipedes and vegetable matter.

On June 1, 1998, on a regular visit to the Nal-Sandol Forest Nursery near Jhadol village in Udaipur dist., Rajasthan, I observed a male *Calotes versicolor* which was swallowing a small *Lycodon aulicus,* approximately 25 cm in length in a nursery-bed at about 0930 h. The anterior half of the snake was already swallowed and it took nearly 6 minutes to complete the process.

After swallowing the prey, it slowly climbed up a *Ricinus communis* tree and settled itself on a twig and remained motionless till 1530 h. A garden lizard feeding on a snake is unusual, hence worthy of placing on record.

Sep. 15, 1998

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16. PYTHON PREYING ON RAT SNAKE

It was raining in Panna National Park, Madhya Pradesh, during late June, 1998. One day, while I was sampling for bear scats down a road, a forest guard I met on the way informed me that a python had been found lying about 100 m off the road. Eager to break the monotony of sampling for scats, I went about looking for it. It was close to the *Kheriah* grassland along a stream bordered with a few riparian trees. I found this young python lying in a small pool of water, holding on to a rat snake effortlessly, biting the mid-body and smothering it. The rat snake helplessly tried to get out of the stranglehold. The python was about 2.1 m long, and the rat snake was a full grown one of about 1.8 m long, but only one-fifth or one-sixth as thick as the python. I watched them for about 15 minutes and left the place so as not to disturb them any longer. I assume that the python must have eaten the rat snake after killing it.

Though seeing a python, particularly during the rainy season, is not unusual in Panna, I was surprised to see it preying on a rat snake. I have not come across reports of python feeding on other snakes. Whitaker (1978) reports mammals and birds as the major food of python, and Daniel (1983) adds monitor lizard and various frogs to its reported prey. Bhupathy and Vijayan (1989) report the various mammal and bird food items eaten by python in Bharatpur, but they have not, in their two year study, recorded python preying on another snake.

November 5, 1998

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17. ABERRANT BANDED RACERS *ARGYROGENA FASCIOLATUS*

(*With two plates*)

In January 1998, the second author found a snake in Ghorawadi, near Talegaon, Pune dist., Maharashtra. It had nine supralabials on each side and 97 paired subcaudals. Barring these two

discrepancies, the snake fits Smith's (1943) description of *Argyrogena fasciolatus* well.

Table 1 provides important details on measurements and scalation of the snake. Additional information is presented below (see also Fig. 1 and 2). Snout strongly projecting; head feebly distinct from neck; rostral large, broader than high; suture between internasals shorter than that between prefrontals; pupil round. Body pale brown above, marked anteriorly with narrow cross bars formed by a pattern of white and dark brown marks; posteriorly, the bars become indistinct and finally disappear towards the tail which is a uniform pale brown above; ventrum uniform enamel white. Head above marbled with light and dark brown; a white spot on the midline of each frontoparietal suture, another on the middle of the interparietal suture. We were unable to sex the snake. The specimen has been deposited at the Bombay Natural History Society (Specimen no. 3175).

Smith (1943) lists eight supralabials as a key character for *A. fasciolatus,* while the number of subcaudals recorded by him are 77-92. Specimens from Pakistan also have eight supralabials (Minton 1966). Though ventral and subcaudal abnormalities have been reported in this species (Gharpurey 1931), we are unaware of any supralabial variation on record.

The two aberrations exhibited by the Ghorawadi individual might seem insignificant by themselves, but together they cause Smith's (1943) key to the species of *Coluber* sensu lato to fail. Using the key alone, without referring to descriptions of each species of *Coluber,* one would wrongly assign this individual to *Coluber ravergieri.*

Before assigning this snake to *Argyrogena fasciolatus,* descriptions and pholidosis of all the species of the *Coluber* complex (sensu Smith 1943) that are known to occur in India were studied (*Coluber, Spalerosophis and Argyrogena*). Photographs of the head shields of the aberrant snake, as well as its scale counts were compared with four previously identified *A. fasciolatus* specimens in the collection of the Bombay Natural History Society. In addition, two specimens of *Coluber ravergieri* were also examined. Finally, the aberrant individual was compared with 12 live *A. fasciolatus.* Five of these were from Pune dist., 7 from around Aurangabad.

Table 1

DATA ON MEASUREMENTS (IN MM) AND SCALATION OF *ARGYROGENA FASCIOLATUS* (SHAW 1802) FROM MAHARASHTRA, INDIA

Features	
Scales (smooth)	21:23:17
Ventrals (obtusely angulate laterally)	217
Anals	2
Subcaudals (paired + one caudal spur)	97
Supralabials (scales contacting orbit in brackets)	9 (5,6)
Infralabials	11
Loreal (longer than tall)	1
Preocular (touches top of head)	1
Presubocular (arguably a divided 4th supralabial)	1
Postoculars	2
Temporals	2 + 3
Snout - vent length	500
Tail length	140

Two of the live snakes from Aurangabad had varying supralabials. One of them had L8 (4,5), R7 (3,4); the other had L9 (5,6), R8 (4,5) supralabials (L - left, R - right, scales contacting orbit in brackets). This lends further credence to the fact that the Ghorawadi individual was indeed an aberrant *Argyrogena fasciolatus* and not a wrongly identified snake.

To conclude, we quote Frank Wall (1907) "...... many people appear to expect a key to direct them unerringly in every case to the object of their enquiry, but the disciple of Darwin, on a little reflection, must see how impossible it is to fulfil such expectations, for it is only through variation that the evolution doctrine can be accepted. Whether the variation is retrogade — a reversion to an ancestral type, or progressive —a deviation towards a new type, the effect is the same, and certain individuals must occur which depart in some way or other from the accepted normal type. This being so, any key, however well constructed, will fail to correctly

Ashok Captain & Sanjay Thakur: *Argyrogena fasciolatus* PLATE 1

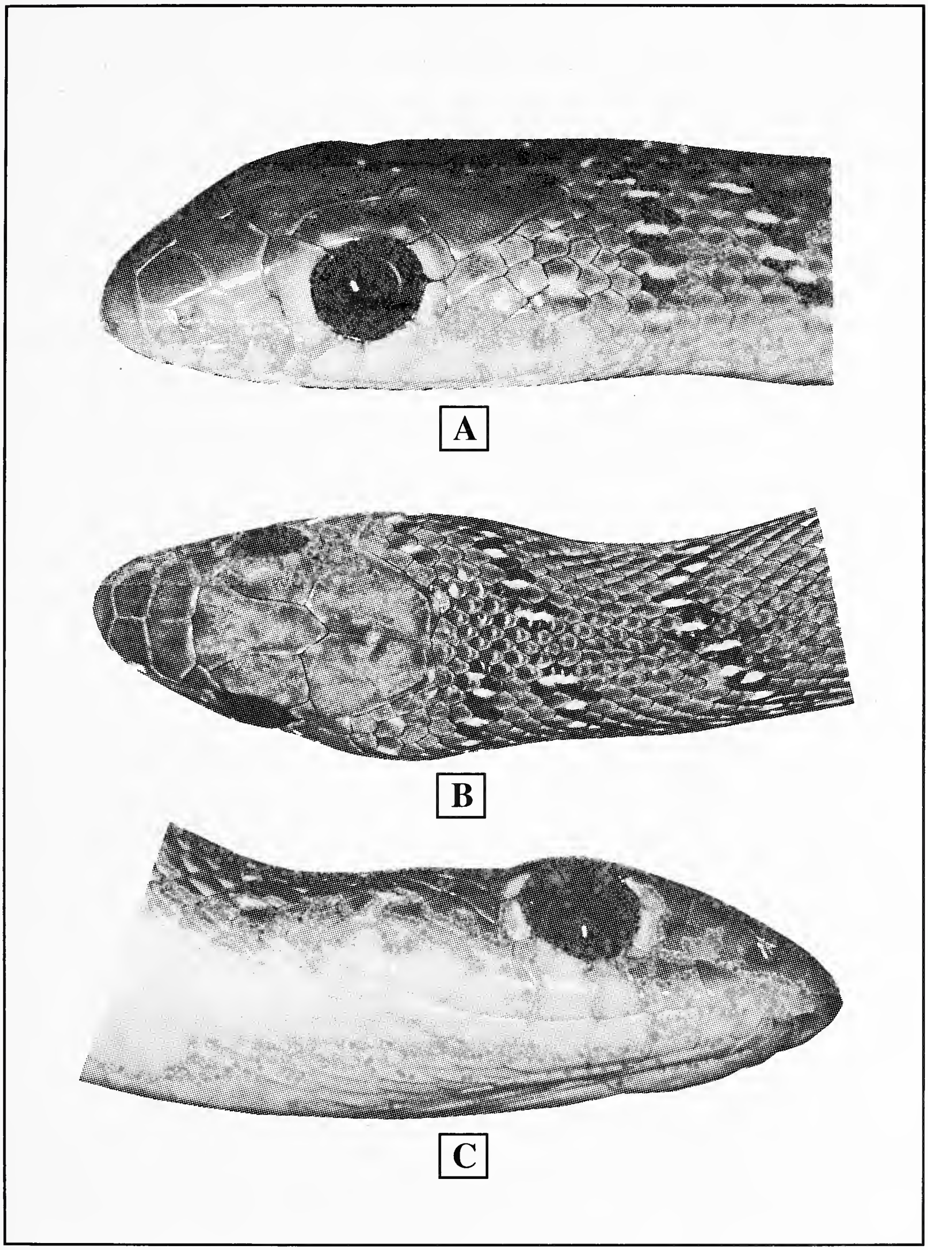

Fig. 1: *Argyrogena fasciolatus* (Shaw 1802). Live aberrant snake from Maharashtra, India.
A. and C. Lateral views of head showing 9 supralabials; B. Dorsal view of head.

PLATE 2

Ashok Captain & Sanjay Thakur: *Argyrogena fasciolatus*

Fig. 2: *Argyrogena fasciolatus* (Shaw, 1802). Live aberrant snake from Maharashtra, India. Dorsal view of body

indicate certain individual specimens. In framing keys, one endeavours to select characters which are found to be most stable in individuals of the same species, so as to minimise the chances of misleading."

Only time will tell whether the Ghorawadi variation is retrograde or progressive.

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We thank alphabetically: N. Chaturvedi, J.C. Daniel, "Doc" Ghate, V. Hegde, J. Kadapatti, S. Kadapatti, A. Khaire and N. Khaire. We also thank the Akurdi Snake Park and Aviary for allowing us to examine all their banded racers.

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18. *BUFO VIRIDIS* IN JAIPUR DISTRICT, RAJASTHAN

(*With one plate*)

During the rainy season, in July 1995, a large number of newly hatched larvae were collected from a temporary pool and juvenile toads were collected from the grass near the pool and from nearby fields, in sand, crevices, and under pebbles from various localities in Jaipur dist., Rajasthan. It was identified at BNHS as *Bufo viridis,* which has been reported earlier from Jammu & Kashmir, north and west of Punjab and Gujarat and now for the first time from Jaipur (Rajasthan).

Bufo viridis, a handsome toad, commonly known as the green toad, grows to a length of 73.5 mm to 98 mm (head to vent). Snout pointed and black, eyes prominent, tympanum distinct.

First finger longer than the second, toes about 2/3 webbed, heels do not meet when the legs are folded at right angles to the body, two shovel-shaped metatarsal tubercles are present. Skin slightly loose laterally, an inverted V-shaped glandular ridge present between the shoulders, a row of white tubercles present along the outer aspect of the forearm and hind limbs, ventrally the skin is glandular.

Body grey, with dark green marbling with reddish centres. Lips, limbs (fore and hind) and toes are barred. Colour of the ventrum white, but throat and chest stippled with brown.

A burrowing species, it is rarely seen above ground except during the breeding season. These toads are excellent burrowers in loose soil, using their powerful metatarsal tubercles to burrow quickly and disappear underground. While burrowing, the soil is dislodged by sideways movements of the legs, and the animal subsides into the ground; the eyes disappear last, leaving no trace above of its presence.The toads move with slow hops and are very feeble swimmers. They can climb well, doing so over grass in a curious manner, with the help of the pads present

at the bases of the 1st and 2nd fingers, while 3rd and 4th fingers help in gripping.

In captivity, they have the peculiar habit of resting all together in a jumbled heap.

Just after hatching tadpoles were collected in large numbers from temporary rain water pools in various localities in Jaipur dist. The tadpoles were small, ranging from 3-4 mm in length. Head and body flat and oval in shape, snout rounded, nostrils small and circular and situated approximately half way between the eye and the tip of snout. Gill situated at some considerable distance behind the eye.

The mouth is terminal as compared to the tadpoles of *Bufo stomaticus*, where it is ventral. The dental formula is 1:1+1/3, the lower row on the upper lip is clearly interrupted. Teeth small and black, very small and feebly developed on the 3rd row of the lower lip. The lower beak almost V-shaped, upper beak convex and minutely denticulated.

Tail long, twice as long as the head and the body, bluntly pointed and has well developed dorsal and ventral fins. The dorsal fin membrane starts from the posterior extremity of the body and rises gradually. The tadpoles are bottom dwellers.

Colour dorsally dark, mottled with green and red circular patches. Dark pigments are also present on the axial fleshy region of the tail. Ventral surface colourless. Forearms, hand, fingers, thigh, shank, tarsus, foot and toes are barred. A fully grown tadpole measures 30-40 mm.

Development is rapid, being completed within 20-24 days. Metamorphosed toadlets measure approximately 10 mm from snout to vent.

August 19, 1998

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19. FOUR NEW RECORDS AND CHECKLIST OF AMPHIBIANS FROM MAHARASHTRA

The amphibian fauna of Maharashtra has been reported by Daniel (1974) in the Maharashtra State Gazetteer. He has listed 22 species. In 1976, Yazdani and Mahabal reported 11 species from Pune. Later, Ravichandran and Pillai (1990), who worked on the amphibian collection at the Western Regional Station, Zoological Survey of India, Pune raised the number of species from Maharashtra to twenty-nine.

In August, 1995 during an amphibian survey along the Western Ghats in south Maharashtra, I recorded 17 species including four, namely *Limnonectes brevipalmata, Rana curtipes, Philautus leucorhinus* and *Rhacophorus malabaricus,* which were not reported hitherto from Maharashtra. The details of collection, morphometry and field notes of the newly recorded species are summarized below.

Limnonectes brevipalmata (Peters 1871)

Material: (1) 1 exp. BNHS 2989; Koyna (550 m), Satara dist., Maharashtra; 16.viii.1995. (2) 4 exp. BNHS 3025, 3039-3041; Amboli (750 m), Sindhudurg dist., Maharashtra; 26.viii.1995.

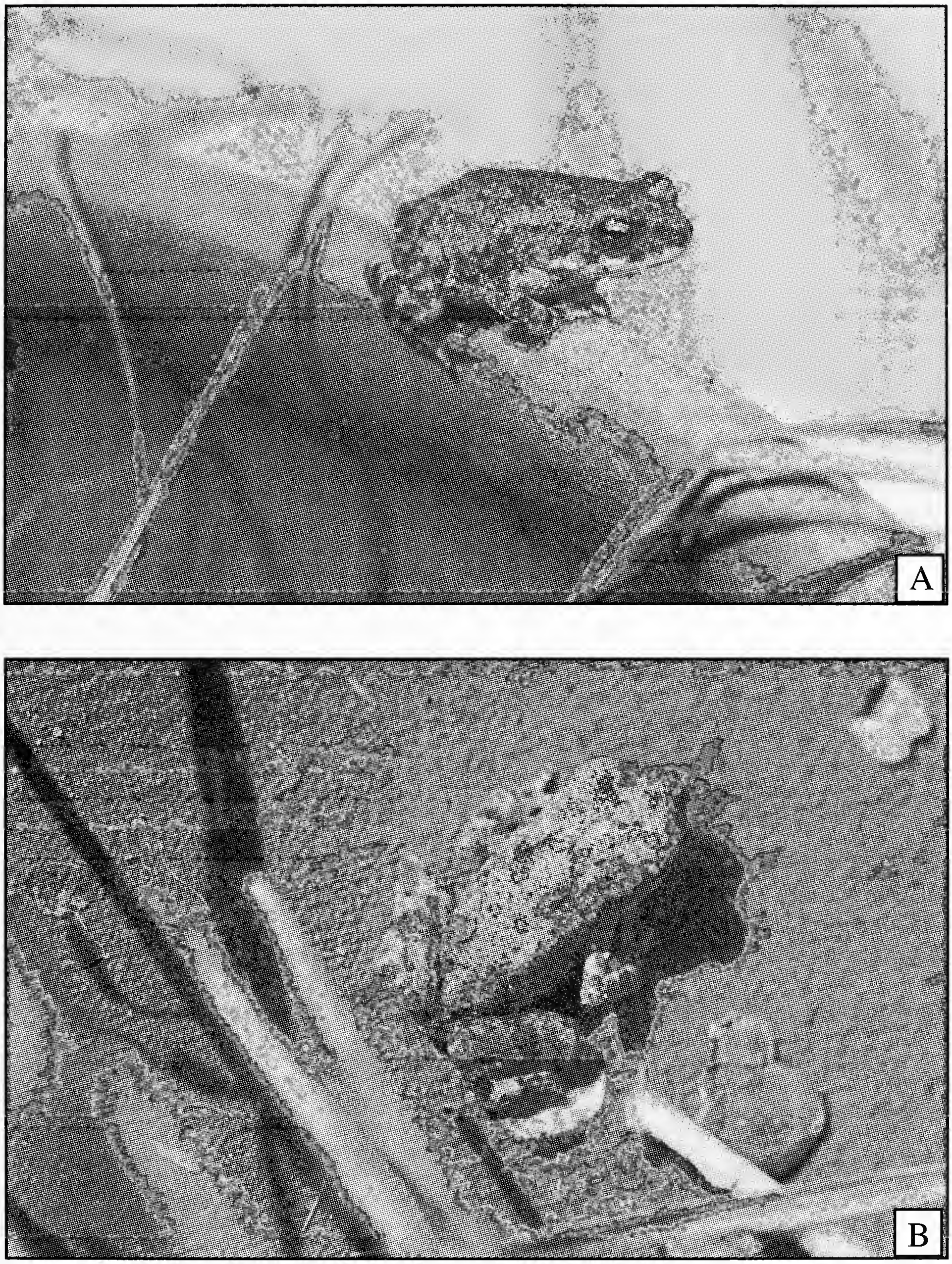
Measurements: Snout-vent length 46.30-53.60 mm; Head length 15.30-16.95 mm; Head width 15.60-17.45 mm; Tibia length 26.65-30.63 mm. All the specimens with vertebral streak.

Field notes: The individual from Koyna was picked up from the short-grass patch in a nursery, whereas the specimens from Amboli were collected from a stone heap in the middle of a big man-made tank with 15 cm of water in semi-evergreen forest.

Rana curtipes Jerdon 1853

Material: 1 exp. BNHS 3038; Amboli

Saroj Saxena: *Bufo viridis* PLATE 1



The green toad *Bufo viridis* recorded for the first time in Jaipur dist. Rajasthan.
A. Lateral view; B. Dorsal view.

(750 m), Sindhudurg dist., Maharashtra; 26.viii.1995.

Measurements: Snout-vent length 60.15 mm; Head length 25.40 mm; Head width 25.1 mm; Tibia length 28.70 mm.

Field notes: The specimen was collected from the damp cement floor of a man-made tank with decayed leaf litter in semi-evergreen forest.

Philautus leucorhinus
(Lichtenstein and Martens 1856)

Material: (1) 2 exp. (2 males); BNHS 2998-2999; Koyna (550 m), Satara dist., Maharashtra; 17.viii.1995. (2) 3 exp. (3 males); BNHS 3013-3015; Kalammawadi (650 m) 10 km from Radhanagari, Kolhapur dist., Maharashtra; 22.viii.1995. (3) 2 exp. (1 male, 1 female); BNHS 3021-3022; Amboli (750 m), Sindhudurg dist., Maharashtra; 25.viii.1995.

Measurements: Snout-vent length of adult female 39.90 mm; Head length 12.05 mm; Head width 12.6 mm; Tibia length 17.5 mm. Snout-vent length of adult males 29.5 mm; Head length 10.15-11.3 mm; Head width 11.3-12.5 mm; Tibia length 15.3-16.5 mm.

Field notes: All the specimens, except one, were collected from the branches and leaves of shrubs growing to a height of 2 m. One individual was taken from a tree trunk, 1 m from the ground. Frogs of this species were heard calling in chorus after sunset in the forest, along with the related species *Philautus bombayensis*, but these two species could be differentiated by their calls in the field. The male and female from Amboli were collected while they were in amplexus. The amplexus was axillary. The pair was kept in a jar to continue their mating. The female laid 58 whitish, spherical eggs which measured 2.5 mm in diameter.

Rhacophorus malabaricus Jerdon 1870

Material: 5 exp. BNHS 3042-3046; Amboli (750 m), Sindhudurg dist., Maharashtra; 26.viii.1995.

Measurements: Snout-vent length 55.6 to 63.1 mm; Head length 18.2-20.5 mm; Head width 14.45-20.4 mm; Tibia length 29.6-32.6 mm; width of toe pad 3.45-4.20 mm.

Field notes: All the frogs were collected in the night at 2010 h. from the branches of a tree, about 5 m above ground level, in semi-evergreen forest. The frogs were highly camouflaged among the colour and shape of the leaves. The tadpoles were found in the forelimb stage, in a man-made tank near the tree from where adult frogs were collected.

The distribution of *Limnonectes brevipalmata* and *Rana curtipes* has been described as Tamil Nadu, Kerala and Karnataka. The bush frog *Philautus leucorhinus* has been collected so far from Kerala, Karnataka and Goa, whereas the Malabar gliding frog *Rhacophorus malabaricus* has been recorded from Tamil Nadu, Kerala, Karnataka and Goa (Sekar 1991). There is no record of these four species from Maharashtra so far, and this is the first report.

Based on the two lists provided by Daniel (1974) and Yazdani and Mahabal (1976) and their work on the ZSI collection, Ravichandran and Pillai (1990) reported 29 species of amphibians from Maharashtra. However, the species list requires some addition and deletion.

Limnonectes syhadrensis, which was recorded from Nasik, Maharashtra was not included in the previous lists. *L. syhadrensis* described by Annandale (1919), was treated as one of the varietals of *Limnonectes limnocharis* (Boulenger 1920). For this reason, Daniel (1974) did not include it in the list of amphibia of Maharashtra. In 1974, Dubois separated this species from *L. limnocharis* (Frost 1985).

Though the Caecilian *Ichthyophis bombayensis* (Taylor 1960) was reported from Maharashtra by Dutta (1992), it was not recorded from Maharashtra in the present study. The species is known only from the type locality Waghai, Surat Dangs, in Gujarat (Frost 1985). With the available information and the results

of the present survey, an updated species list of the amphibian fauna of Maharashtra, comprising of 2 orders, 6 families, 17 genera and 34 species, has been prepared according to the new classification (Dutta 1992).

UPDATED SPECIES LIST OF AMPHIBIANS OF MAHARASHTRA

ORDER: APODA

1. FAMILY: Ichthyophiidae Taylor 1968
   1. Genus *Ichthyophis* Fitzinger 1826
      1. *Ichthyophis subterrestris* Taylor 1960

2. FAMILY: Caeciliidae Gray 1825
   2. Genus *Indotyphlus* Taylor 1960
      2. *Indotyphlus battersbyi* Taylor 1960

ORDER: ANURA

3. FAMILY: Bufonidae Gray 1825
   3. Genus *Ansonia* Stoliczka 1870
      3. *Ansonia kamblei* Ravichandran 1992
   4. Genus *Bufo* Laurenti 1758
      4. *Bufo melanostictus* Schneider 1799
      5. *Bufo beddomii* Günther 1875
      6. *Bufo stomaticus* Lütken 1862
      7. *Bufo parietalis* Boulenger 1882
      8. *Bufo microtympanum* Boulenger 1882
      9. *Bufo koynayensis* Soman 1963

4. FAMILY: Microhylidae Günther 1859
   5. Genus *Microhyla* Tschudi 1838
      10. *Microhyla ornata* (Duméril and Bibron 1841)
      11. *Microhyla rubra* (Jerdon 1854)
   6. Genus *Uperodon* Duméril and Bibron 1841
      12. *Uperodon globulosus* (Günther 1864)
   7. Genus *Ramanella* Rao and Ramanna 1925
      13. *Ramanella montana* (Jerdon 1854)
      14. *Ramanella variegata* (Stoliczka 1872)

5. FAMILY: Ranidae Gray 1825
   8. Genus *Euphlyctis* Fitzinger 1843
      15. *Euphlyctis cyanophlyctis* (Schneider 1799)
      16. *Euphlyctis hexadactylus* (Lesson 1834)
   9. Genus *Hoplobatrachus*
      17. *Hoplobatrachus tigerinus* (Daudin 1803)
   10. Genus *Limnonectes* Fitzinger 1843
      18. *Limnonectes limnocharis* (Boie in: Wiegmann 1835)
      19. *Limnonectes brevipalmata* (Peters 1871)
      20. *Limnonectes keralensis* Dubois 1890
      21. *Limnonectes syhadrensis* (Annandale 1919)
   11. Genus *Indirana* Laurent 1986
      22. *Indirana beddomii* (Günther 1875)
      23. *Indirana leithii* (Boulenger 1888)
   12. Genus *Rana* Linnaeus 1758
      24. *Rana malabarica* Tschudi 1838
      25. *Rana curtipes* Jerdon 1853
      26. *Rana temporalis* (Günther 1864)
   13. Genus *Tomopterna* Duméril and Bibron 1841
      27. *Tomopterna breviceps* (Schneider 1799)
      28. *Tomopterna rufescens* (Jerdon 1854)
   14. Genus *Nyctibatrachus* Boulenger 1882
      29. *Nyctibatrachus humayuni* Bhaduri and Kripalani 1955

6. FAMILY: Rhacophoridae Hoffman 1932
   15. Genus *Philautus* Gistel 1848
      30. *Philautus glandulosus* (Jerdon 1853)
      31. *Philautus leucorhinus* (Lichtenstein and Martens 1856)
      32. *Philautus bombayensis* (Annandale 1919)
   16. Genus *Polypedates* Tschudi 1838
      33. *Polypedates maculatus* (Gray 1834)
   17. Genus *Rhacophorus* Kuhl and Van Hasselt 1822
      34. *Rhacophorus malabaricus* Jerdon 1870

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20. RANGE EXTENSION IN *UPERODON GLOBULOSUS* (GUNTHER 1864) IN ASSAM

Uperodon globulosus (Günther 1864) is a fossorial microhylid occurring in India and Bangladesh (Inger and Dutta 1986, Khan 1982). In India, it is distributed in Assam, West Bengal, Orissa, Maharashtra, Gujarat, Madhya Pradesh, Karnataka and Goa (Daniel 1963, Inger and Dutta 1986, Dutta 1997). In Assam, it was reported from Kamrup, Nalbari, Barpeta and Kokrajhar districts (Chanda 1994, Sengupta unpublished data).

On June 6, 1998 a pair of *Uperodon globulosus* were collected from Biswanath Plain (93° 25' E and 26° 45' N, Sonitpur dist., at 2015 h. from a low-lying temporary waterlogged grassland around a perennial pond. Both were mature females (SVL 6.7 and 6.9 cm). These represent a range extension by *ca.* 135 km northeast, the previous easternmost point of distribution being Mandakata (91° 47' E, 26° 17' N) in Kamrup dist. In Assam, the species is found along the floodplain from Kokrajhar dist., upto Sonitpur dist., on the north bank of the Brahmaputra, and only a single record (Chanda 1994) — Jalukbari has been reported from the south bank.

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21. *EUPHLYCTIS HEXADACTYLUS* (LESSON) FEEDING ON *XENOCHROPHIS PISCATOR* (SCHNEIDER)

Unlike other adult amphibians, the Indian green frog *Euphlyctis hexadactylus* (Lesson) is the only known folivore (Das 1995). The principal diet includes aquatic macrophytes, Mollusca, Arthropoda, and among Chordata, fish and amphibians (Das 1995, 1996). There are reports of other frogs (*Polypedates maculatus*) feeding on a juvenile *Hemidactylus frenatus* (Das 1996).

On November 12, 1997, while conducting an amphibian survey along the Kodungarai River in Anaikatty on the border of Tamil Nadu and Kerala states, I observed an adult *Euphlyctis hexadactylus* feeding on a checkered keelback snake *Xenochrophis piscator* (approx. 0.3 m in size). It took the frog about 3 minutes to swallow the prey.

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22. FIRST RECORD OF *HOPLOBATRACHUS CRASSUS* (JERDON 1853) FROM NORTH EASTERN REGION IN ASSAM AND ARUNACHAL PRADESH

(*With one text-figure*)

Hoplobatrachus crassus was originally known as *Rana crassa* (Jerdon). Dutta (AMPHIBIANS OF INDIA AND SRI LANKA — CHECKLIST AND BIBLIOGRAPHY, 1997) gave the distribution as Andhra Pradesh, Kerala, Tamilnadu (Madurai dist., Madras: Mamallapuram), Karnataka, Uttar Pradesh, Madhya Pradesh, West Bengal (Midnapur dist.), Orissa (throughout coastal districts).

We record its occurrence in the North Eastern Region of India. Two male specimens were collected from swampy areas in Chessa (27° 10' N lat, 93° 40' E long.), Papumpare dist., Arunachal Pradesh, situated at 500 m above msl. Two male and four female specimens were collected from Gahpur (26° 31' N lat, 92° 21' E long.), Sonitpur dist., Assam, at 200 m above msl.

The specimens have been deposited at Cotton College Museum (CCM). Specimen nos. CCM 628-1 male, CCM 628-2 male, CCM 628-3 female, CCM 628-4 female, CCM 628-5 male, CCM 628-6 female, CCM 628-7 female. One specimen is deposited at BNHS Museum, identification confirmed by BNHS, Mumbai by letter of ref. no. 100/98.

Description: Dorsal surface of male dark with black spots. Ventral surface creamy white with black patches on the throat region. Dorsal surface of female brown with chocolate brown spots. Ventral surface creamy white with dark patches on the throat region.

Measurements (in cm) - Snout-vent length 4-8.1, Head length 1.4-2.6, width 1.3-2.6; Length of snout 0.7-1.4, Maximum length of eye 0.4-0.9, Interorbital space 0.25-0.6, Length

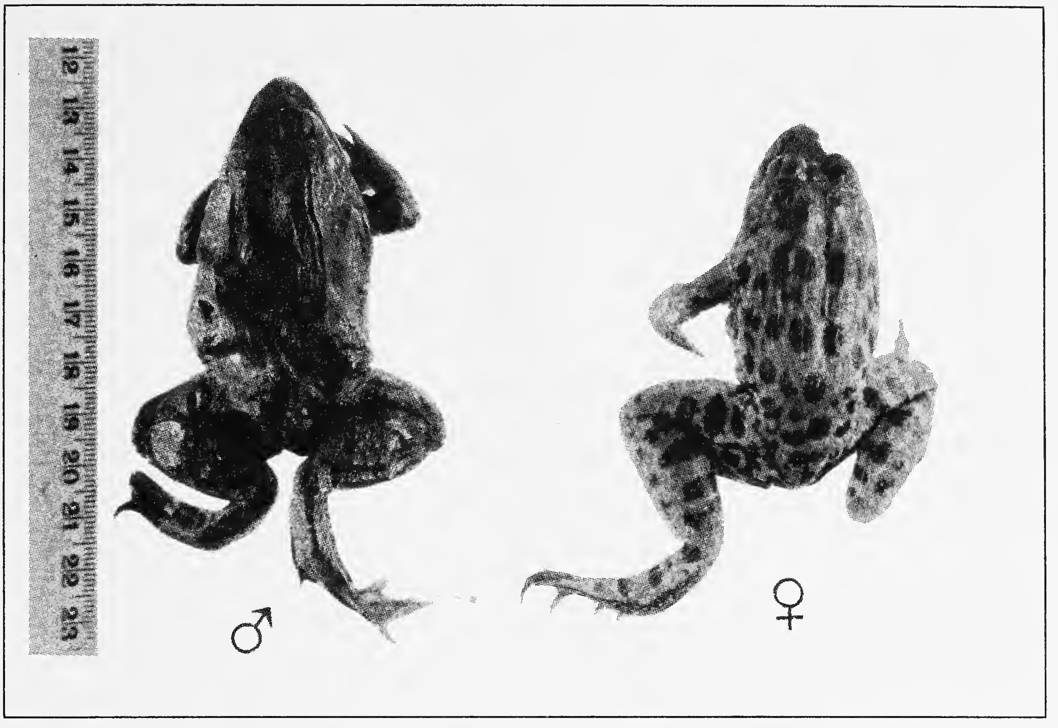

Fig. 1: Male and female specimens of *Hoplobatrachus crassus* (Jerdon 1853)

of arm 1.7-3.8, Tympanum 0.35-0.7, Length of hand 0.83-1.6, 1st finger 0.5-0.8, second finger 0.4-0.7, 3rd finger 0.6-1.1, 4th finger 0.3-0.6, Length of leg 5.5-11.0, Length of Tibia 1.8-3.0, Length of Foot 0.85-3.6, 1st Toe 0.25-0.5, 2nd Toe 0.4-0.7, 3rd Toe 0.65-1.1, 4th Toe 0.95-2.3, Fifth Toe 0.7-1.1. Tibiotarsal articulation reaches tympanum.

H. crassus shares a common habitat with *H. tigerinus* (Daudin 1803).

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23. DISTRIBUTION OF FISH IN THE MANJESWARAM RIVER, KASARAGOD (KERALA)

Distribution of freshwater fishes of northern Kerala, north of the Palghat Gap, was studied by various workers in the past (Rajan 1955, Mukerji 1931, Rema Devi and Indra 1986). Recently Shaji and Easa (1997) reported on the hill stream fishes of the Kerala portion of Nilgiri Biosphere Reserve. However, there has been no record of the fish fauna of the rivers flowing through Kasaragod dist., Kerala.

The Manjeswaram river, one of the smaller rivers in Kerala, was surveyed during October-November 1997. This river originates at 60 m

above msl, from the shrub-covered hills situated at the northern border of Kerala, in Kasaragod dist. This river has a length of 16 km and a catchment area of 90 sq. km, width of about 10-50 m and depth. 2-9 m. The bottom is sandy or muddy in most parts.

Collections were made, using cast net, gill net and scoop net of varying mesh size. A total of 20 species representing 11 families were collected, as listed below:

FAMILY ANGUILLIDAE

1. *Anguilla bengalensis bengalensis* (Gray)

FAMILY CYPRINIDAE

Subfamily - Cyprininae

2. *Puntius amphibius* (Val.)
3. *P. filamentosus* (Val.)
4. *P. vittatus* Day

Subfamily - Rasborinae

5. *Danio aequipinnatus* (McClelland)
6. *D. malabaricus* (Jerdon)
7. *Parluciosoma daniconius* (Ham.-Buch.)

Subfamily - Garrinae

8. *Garra mullya* (Sykes)

FAMILY BAGRIDAE

9. *Mystus gulio* (Ham.-Buch.)
10. *M. armatus* (Day)

FAMILY BELONIDAE

11. *Xenentodon cancila* (Ham.-Buch.)

FAMILY APLOCHEILIDAE

12. *Aplocheilus lineatus* (Val.)

FAMILY THERAPONIDAE

13. *Therapon jarbua* (Forskal)

FAMILY GERREIDAE

14. *Gerres lucidus* (Cuvier)

FAMILY CICHLIDAE

15. *Etroplus maculatus* (Bloch)
16. *E. suratensis* (Bloch)
17. *Oreochromis mossambica* (Peters)

FAMILY MUGILIDAE

18. *Mugil cephalus* Linn.

FAMILY GOBIDAE

19. *Glossogobius giuris* (Ham.-Buch.)

FAMILY BELONTIDAE

Subfamily - Macropodinae

20. *Macropodus cupanus* (Val.)

Freshwater fish are a small part of the biodiversity in the small rivers of Kasaragod dist., compared to other rivers in Kerala. This may be because of few habitat types in this river. The chief substratum in most parts of this river is sand and mud. Hence *Puntius amphibius, Parluciosoma daniconius, Danio malabaricus, Aplocheilus lineatus* and *Glossogobius giuris* are the most abundant and uniformly distributed fishes in this river.

Marine species like *Therapon jarbua, Gerres lucidus* and *Mugil cephalus* were collected in large numbers from the river mouth and also a few kilometres away from the sea.

A total of 20 species belonging to 11 families were collected from this river, most of which are widely distributed throughout Kerala.

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24. OCCURRENCE OF *TETRAODON TRAVANCORICUS* (HORA AND NAIR) IN THE CHALAKUDY, PERIYAR AND KECHERY RIVERS, KERALA

Malabar puffer fish (*Tetraodon travancoricus*) is a small species of less than 3 cm total length. Hora and Nair (1941) reported this species from Pamba river, Kerala. After a long period, this species was reported again from inundated brickyards at Pudukkad, Trichur, Kerala (Inasu 1993). Apart from these observations, there was no report on this fish from other rivers in Kerala.

Distinguishing Characters: D 7-8; A 8; P 16-18

T. travancoricus is characterised by an oblong and laterally compressed body; arched dorsal profile, highest at the middle of back; flat inter-orbital space; terminal mouth that is directed forward; nostril a hollow tube, nearly as high as wide, only its distalmost part formed into two very small lobes which are bent inwards, giving a key-hole appearance to the nares.

Remarks: Specimens were collected from Kanakkankadavu area of Chalakudy river, Thattakad and Kalady regions of Periyar river and Puzhakkal area of Kechery river, and this is the first report of the species. This species was not reported by earlier studies conducted in the Chalakudy and Kechery rivers (Thobias 1973, Antony 1973 and Inasu 1991).

In a study on the sexual dimorphism, Inasu (1993) reports, all the males of this species should have a dark bluish ventral band from mouth to the caudal region. However, we observed that the number of males with the above mentioned character were less than the female specimens. Out of the 56 specimens collected from Chalakudy river, only four specimens appeared male. Furthermore, it appeared in large groups, occasionally in hundreds, observed mainly during the summer months (January to May) and very rarely during the rainy season. Local fishermen consider this fish as "frog tadpoles". The present report extends its distribution to three more rivers in Kerala.

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25. NEW RECORD OF *SALMOSTOMA SARDINELLA* (PISCES: CYPRINIDAE) FROM MONDAI STREAM, MAHARASHTRA

(*With one text-figure*)

While conducting a survey on the freshwater fishes of Maharashtra, five specimens of *Salmostoma sardinella* (Cyprinidae) were collected from Mondai stream in Satara dist., Maharashtra. The species has not been recorded so far from this state.

The Mondai stream originates from Mandhardevi hills and meets the river Neerar. The fish was collected 1 km from Shirrai in Satara dist. It is a moderate flowing stream. Substrate types are small boulder (20%), gravel (20%), cobblestones (34%) and sand (26%).

The typical features of *S. sardinella* are as follows:

Body elongate and compressed. Dorsal profile equally convex as ventral profile, caudal deeply forked. Lateral line scales 54-56. It grows upto 15 cm (Talwar and Jhingran 1991); in the present collection the range is 6.5-8.1 cm. Head length 4.5 to 4.6 times in standard length. Body depth 5.5 to 6 times in standard length. Colour of live fish silvery. After preservation, dorsal part of body pale brown; ventral part of body pale yellow.

Valenciennes (1842) described this species from Rangoon (Burma). Day (1878) recorded it from Irrawadi river at Rangoon. Tilak (1967) recorded it from Poonpun river, Patna. Talwar and Jhingran (1991) give its distribution as Ganga, Brahmaputra drainage and Orissa. The present record of this fish in Mondai stream extends its distribution to Maharashtra.

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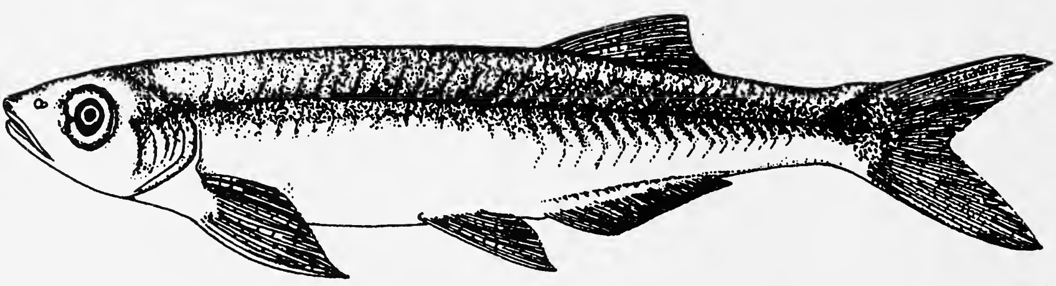

Fig. 1: *Salmostoma sardinella*

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26. EXTENSION OF RANGE OF *ESOMUS THERMOICOS* (PISCES: CYPRINIDAE: RASBORINAE) TO KERALA

Esomus thermoicos Valenciennes 1842 was described from the hot springs at Kanniya, Sri Lanka (type locality). It was thought to be restricted to Sri Lanka until 1992, when it was found in the Kalakad Wildlife Sanctuary, Tirunelveli district, Tamil Nadu, India (Rema Devi 1992). The present record of the species from a freshwater pond adjacent to Mangalampuzha, a tributary of Bharathapuzha, extends its range of distribution to Kerala. The present report is based on three specimens averaging 85 mm SL collected during 1997.

Esomus thermoicos (Val.)

Nuria thermoicos Valenciennes 1842, Hist nat. Poiss; 16: 238; pl. 472

Esomus thermoicos: Hora & Mukerji 1928, Rec. Ind. Mus; 30(1): 44.

Esomus danrica thermoicos: Munro 1955, Marine and freshwater fishes of Ceylon: 42, pl. 7.

Distinguishing features

D i 7; A iii 5; P i 13-14; V i 7.

Esomus thermoicos is a heavy bodied species and the length of its head is nearly equal to the depth of the body, which is about 4.4 times in standard length and the maxillary barbels extend nearly to the tip of the pectoral fin. Lateral line with 32-34 scales.

Distribution: Sri Lanka; INDIA: Kalakad Wildlife Sanctuary, Tamil Nadu and wetlands of Kerala.

Remarks: Dr. P.E.P. Deraniyagala of the Colombo Museum informed Dr. S.L. Hora of Zoological Survey of India, Calcutta that no *Esomus danrica* was to be found within a radius of 300 yards of the hot springs at Kanniya, Sri Lanka, judging from two collections of fishes from these springs. Other fishes including the peculiar *Puntius (Barbus) thermalis* were also absent in Kanniyan springs (Talwar and Jhingran 1991).

From India, this species has so far been reported only from Kalakad WLS, Tamil Nadu (Rema Devi 1992). The present report extends its distribution to Kerala.

We are grateful to Dr. K. Rema Devi, Scientist, ZSI, Southern Regional Station, Chennai, for confirming our identification of the species.

February 14, 1998

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27. SEXUAL DIMORPHISM IN CAT FISH *OMPOK BIMACULATUS* (BLOCH)

(*With two text-figures*)

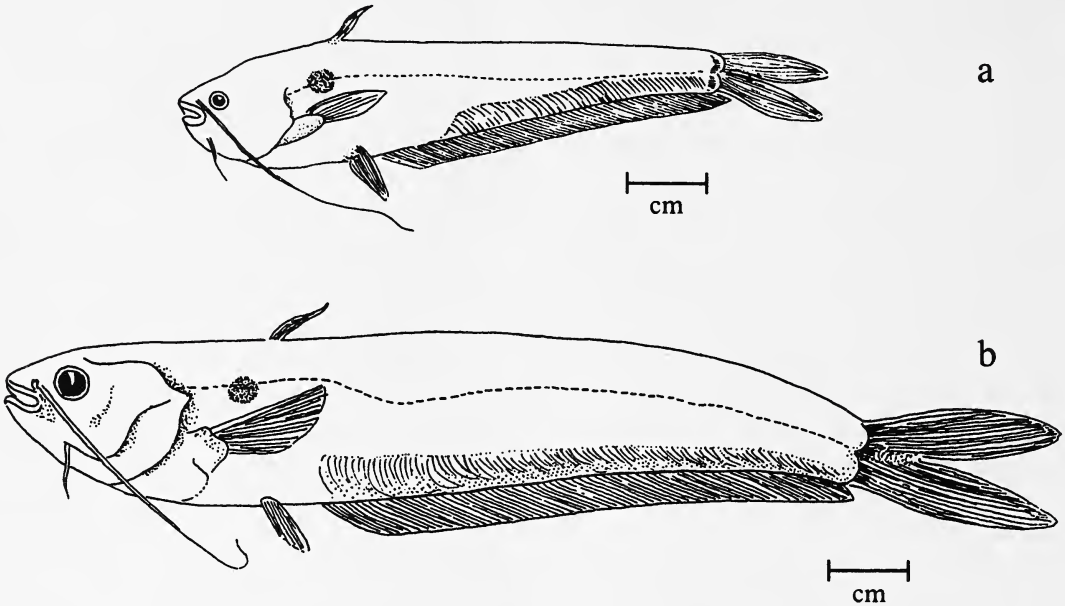

Fig. 1: *Ompok bimaculatus* (Bloch): a. male; b. female.

The study of sexual dimorphism is important in taxonomy, bionomics and reproductive biology. It is also significant in biodiversity assessments. This paper deals with sexual dimorphism in an edible cat fish *Ompok bimaculatus* (Bloch).

The genus *Ompok* (Lacepede) has three species: *Ompok bimaculatus* (Bloch) *O. pabda* (Hamilton) *O. pabo* (Hamilton).

Thobias (1974) reported on the sexual dimorphism of the filament barb *Puntius filamentosus* (Val.). Inasu (1993) observed sexual dimorphism in a freshwater puffer fish, *Tetraodon travancoricus* Hora and Nair. Tessy and Inasu (1997) worked out the sexual dimorphism of an edible perch, *Priacanthus hamrur* (Cuv. and Val.).

Twenty adult specimens were collected from Muriyad (Kole land) and Nedumbal (Kole land) of the inland waters of Trichur dist., during June-September 1997. The body cavity of each fish was cut open and the gonads were exposed. Specimens with testes and those with ovaries were separated. Morphological differences between the two groups were studied and illustrated.

Distinct sexual dimorphism is present in *Ompok bimaculatus* (Bloch). Females are nearly twice as long and five times heavier than males of the same age group (Fig. 1a, b). Dorsal profile of the head of the male has a clear downward slope, but is more or less straight in the female (Fig. 1a, b). A conspicuous, wide, crescent-shaped groove is present on the ventral side of the head in female, but absent in male (Fig 2a, b). The lateral line in the female has a downward bend at the middle of the body, while it is straight in male in the middle portion and slopes downwards only near the operculum (Fig. 1a, b). Eyes of the female bulge conspicuously, while

MORPHOLOGICAL DIFFERENCES BETWEEN THE MALE AND FEMALE OF *OMPOK BIMACULATUS* (BLOCH)

		Male	Female
1.	Average total length	14.8 cm	25 cm.
2.	Average standard length	12.7 cm	22.3 cm
3.	Maximum width	2.7 cm	5 cm
4.	Average weight	20.5 gm	114.4 gm
5.	Average head length	2.5 cm	4.2 cm
6.	Average interobital space	1.7 cm	2.8 cm
7.	Average length of caudal peduncle	0.5 cm	0.8 cm

Fig. 2: *Ompok bimaculatus* (Bloch) ventral view of head: a. female; b. male

the male has very small eyeballs. (Fig. 1a, b). The maxillary barbels in female do not extend beyond the pectorals, while in males they extend beyond the pectorals (Fig. 1a, b). Central rays of the caudal fin in female have dark longitudinal stripes, but these are absent in males. The entire skin of the female is darker than that of the male.

Sexual dimorphism in fishes is exhibited in size and weight. In some fishes, the males are larger than females of the same age group, but in others the females are larger. Inasu (1993) observed that males are larger than females of the same age group in *Tetraodon travancoricus* Hora and Nair, while Tessy and Inasu (1997) observed that in the edible perch *Priacanthus hamrur* (Cuv. and Val.) females are more than twice as large and heavy as males of the same age group. In *Ompok bimaculatus* (Bloch), the female is more or less twice as large and five times heavier than males of the same age group.

We thank Rev. Fr. Jose Chittilappilly, Principal, Christ College, Irinjalakuda for giving facilities to conduct this study. We are also grateful to Sri Thankappan (fisherman, Muriyad) for specimens.

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28. *MACROSPINOSA CUJA* (HAM.-BUCH.) A NEW RECORD FROM KERALA

Sciaenid fishes are an important fishery resource in the warm coastal waters and estuaries of the world. Many species use the estuarine environment as a nursery and feeding ground for the young; they also ascend rivers but do not live there permanently. 20 genera of the family Sciaenidae are recorded from the Indian region, of which 11 genera inhabit inland waters (Talwar and Jhingran 1991).

Macrospinosa cuja (Ham.-Buch.)

Bola cuja Ham.-Buch. 1822, Fishes of Ganges: 81, 369, pl. 12, fig. 27 (type locality: estuaries of Ganges).

Sciaena cuja Day, 1876 Fishes of India: 187; Day, 1889, Fauna of British India, Fishes, 2: 115.

Macrospinosa cuja Talwar, Fauna of India, Pisces: (in press), fig. 3.

Distinguishing features: D X-XI + I 27-29; A II 6-7; P I 17; V 15.

Body elongate with a rather blunt snout; snout profile evenly decurved in young, flatter over eyes with age, profile then rising steeply to occiput and highly arched back. Dorsal fin deeply notched, second to fourth spines with stout bases, third spine longest. Second anal spine robust. Caudal fin rhomboid. It can be easily identified by the presence of a series of oblique, dark scales above the lateral line and faintly horizontal streaks below the lateral line.

Distribution: India: Gangetic estuary, lower reaches of Chalakudy river (Kerala).

Remarks: From India, *Macrospinosa cuja* has so far been reported only from the Gangetic estuary. From the erstwhile Travancore, seven other species of the family Sciaenidae were reported, but not *M. cuja*, (Pillai 1929). Three species of the genus *Sciaena* were recorded from Malabar region (Day 1865). Earlier studies conducted in Kerala did not report *M. cuja* from fresh waters of Kerala. Specimens collected from Kanakkankadavu area, Ernakulam dist., in the Chalakudy river extends the range of *Macrospinosa cuja* to central Kerala. Kanakkandavu is located near the confluence of Periyar and Chakaludy rivers less than 40 m above msl and 19 km away from the sea coast.

Chalakudy and Mangalapuzha, a branch of Periyar river, join at Elanthikara, where tidal influence can be noticed in Chalakudy river. Before it joins with the Periyar river, a temporary sand bund is constructed near Kanakkankadavu, mainly to prevent the mixing of salt water and fresh water. During the rainy season this bund breaks and fresh water mixes with the sea water, facilitating the migration of marine fishes. The present collection was taken from the freshwater side of the river. Hence, it can be concluded that this fish may migrate to the fresh water during the rains for breeding and feeding and may be trapped there when the bund is constructed. The present observation also showed the survival of this fish in fresh water with very little trace of salinity. The type locality of *M. cuja* is the estuary of River Ganges. 9 sciaenid fishes have so far been recorded from Malabar and Travancore areas of Kerala. This is the first record of this species from the fresh waters of Kerala.

ACKNOWLEDGEMENTS

We thank the local fishermen who helped to collect specimens and Dr. K. Remadevi, Scientist, ZSI, Regional Station, Chennai, for confirmation of identification.

May 30, 1998

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29. NEW RECORD OF *STIGMATOGOBIUS OLIGACTIS* (BLEEKER) FROM INDIA

(*With one text-figure*)

One specimen of *Stigmatogobius oligactis* (Bleeker) was collected from Dhom reservoir of Satara dist., Maharashtra. Dhom reservoir is a man-made impoundment across the Krishna and Vaitali rivers. This species is not recorded anywhere in India by earlier workers. Hence it is a new record for India.

Day (1878) Hora and Misra (1942), Suter (1944), Kulkarni and Ranade (1974), Jeyaram (1981), Talwar and Jhingran (1991), Ghate and Pawar (1992), Menon (1992) do not mention this species. Extralimitally, Weber and Beaufort (1953) recorded it from rivers of Java.

Habitat: The substrate is mixed with sand and boulders.

Diagnostic features: Body elongate, anteriorly cylindrical, posteriorly compressed. Head depressed. Snout convex, tongue bilobate. Head scaled above, behind the eye, and laterally on opercle with large cycloid scales. Head with crowded blackish spots on lateral sides.

Measurements of specimen: Total length 4.5 cm, Standard length 3.6 cm, Head length 1.2 cm, Head width 0.7 m, Eye diameter 0.3 cm, Body depth 0.7 cm, Snout length 0.3 cm, Mouth width 0.6 cm, Predorsal scales 10. Lateral line scales 29. Depth of caudal peduncle 0.4 cm. Dorsal fin D1 VI; D2 i/6, A i/6, Pectoral fin 18.

ACKNOWLEDGEMENTS

We thank Prof. Madhav Gadgil, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, for financial assistance under Western Ghats Biodiversity Network; Dr. K. Rema Devi, Zoological Survey of India, Southern Regional Station, Chennai for confirming identification and Dr. P.T. Cherian, Officer-in-Charge, ZSI, Southern Regional Station, Chennai fcr facilities.

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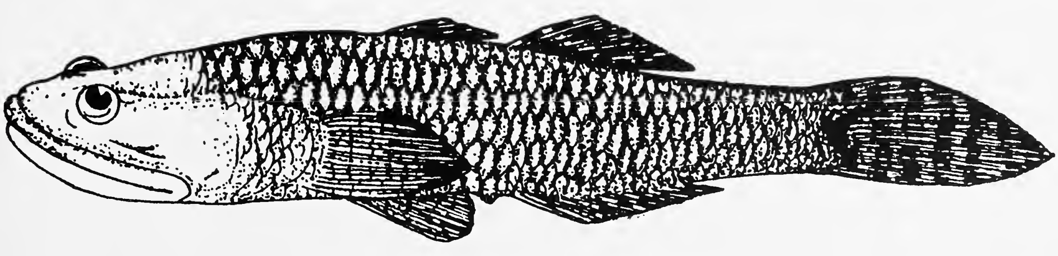

Fig. 1: *Stigmatogobius oligactis* (Bleeker)

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30. NEW LARVAL FOOD PLANTS OF THE TAILED JAY BUTTERFLY *GRAPHIUM AGAMEMNON* LINN., PAPILIONIDAE

The Tailed Jay butterfly is an inhabitant of urban areas and can be seen throughout the day, flying in the vicinity of its larval food plants. On Sept. 11, 1997, I noticed a caterpillar of the Tailed Jay on the leaf of a tree. A branch of the tree was collected and was later identified as *Artabotrys hexapetalus* (Linn.), locally known as Hirva champa. It is a large climbing shrub, commonly grown in gardens for its fragrant flowers. While working on butterflies at the Borivli National Park, I had also seen many caterpillars of this species on a *Polyalthia cerasoides* tree growing on the periphery of the park.

The caterpillar of the Tailed Jay, according to Sevastopulo (1973) *JBNHS 70(1)*: 156-183 are known to feed on *Saccopetalum tomentosum, Annona muricata, A. squamosa, A. discolor, A. reticulata, Polyalthia longifolia,* all belonging to Family Annonaceae; *Michelia champaca* Family Magnoliaceae, and *Cinnamomum* of the Family Lauraceae.

November 17, 1997

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31. BLACK RAJAH *CHARAXES FABIUS* ATTRACTED TO LIGHT IN TADOBA NATIONAL PARK

Hundreds of species of insects are known to be attracted to light. However, this attraction is little known in butterflies, which are usually diurnal.

Thorne (1960) published his observations on North American butterflies attracted to light. Donahue (1962) recorded butterflies attracted to light in India, and mentioned that further observations and experimentation will undoubtedly help in the interpretation of this interesting phenomenon. Shull and Nadkerny (1967) in a paper on "Insects attracted to Mercury Vapour Lamp in the Surat Dangs" have reported four species of family Nymphalidae.

The present observation was recorded during a faunistic survey of Tadoba National Park in December 1996, when one of us (RMS) witnessed a somewhat baffling incident on the night of December 6. While collecting insects attracted to light outside Rest House No. II around 2200 h, we saw a butterfly suddenly dashing against a tubelight. For a moment we thought it

was either a strong flying sphingid moth or the common Evening Brown, a regular visitor to light. These two normally flutter for a while and settle. Their respective flights are also unique. But the speed with which this butterfly struck the light source was startling. It rested for a fraction of a second and then started moving restlessly in the verandah at the same speed. We finally managed to net it and to our surprise, it was an unusual visitor to light, the Black Rajah (*Charaxes fabius*) male.

The Black Rajah is widely distributed but rarely seen, as it flies high, and normally occurs in forested areas near water. It visits dung, filth or over-ripe fruits and toddy juice during the day time, and has never been encountered at night.

Haribal (1982) states that she has seen this species being attracted to chemicals in the laboratory, possibly to alcohol. Its nocturnal visit to light is really baffling.

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32. FIRST RECORD OF *CASSIDA FLAVOGUTTATA* SPAETH (COLEOPTERA: CHRYSOMELIDAE: CASSIDINAE) FROM SATARA DISTRICT, MAHARASHTRA

Spaeth had described *Cassida flavoguttata* in 1914 on the basis of specimens collected by H.L. Andrews from Nilgiri Hills [THE FAUNA OF BRITISH INDIA INCLUDING CEYLON AND BURMA. COLEOPTERA: CHRYSOMELIDAE (CLASSIDINAE & HISPINAE) Maulik 1919]. We have not done extensive literature search. However, we had access to a part of Prof. Dr. Borowiec's ongoing compilation on cassidine beetles of the world and it is clear that this species has not been reported for a long time (Prof. Lech Borowiec, Wroclaw University, Poland, pers. comm.).

We recently came across this beautiful beetle (late monsoon, Sep.-Oct 1997), at a place about 200 m from the northern part of Kas reservoir, Kas, Satara dist. It was found in mixed shrub vegetation and the host plant could not be identified.

We thank Dr. M.L. Cox and Identification Services, International Institute of Entomology (IIE), London (now CABI Bioscience UK Centre at Egham, Surrey), for confirming the identity of the species. We are indebted to Prof. Lech Borowiec (Wroclaw University, Poland) for providing valuable information on Asiatic Cassidinae and to the authorities of Modern College, Pune, for facilities.

August 8, 1998

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33. FIRST RECORD OF *COPIDOGNATHUS FAUBULI* BARTSCH (HALACARIDAE: ACARI) FROM THE INDIAN OCEAN

(*With seven text figures*)

A female specimen of *Copidognathus faubuli* Bartsch, encountered among the thalli of *Halimeda opuntia* from Mus Island, Nicobar Is., is reported here for the first time from the Indian Ocean. This species was earlier described from Philippines by Bartsch (1986). This is also the first report of the species outside its type locality. A brief description is given below.

The idiosomal length is 280 µm. All dorsal plates are separate and sculptured with rosette pores and fovea (Fig. 1). Anterior portion of anterodorsal plate (AD) is gable-like. Areolae are inverted 'Y'-shaped and present in the anterior region of AD. The two ds_1 are located in the two arms of the inverted 'Y'-shaped areolae present on AD and the ds_2 on the anteromedian margin of ocular plate (OC). Posterior portion of OC tapers and extends beyond the insertion of leg III. Four costae are present embedded in the posterodorsal plate (PD). Middle two costae are 2-3 pores wide, while the paracostae are 1-2 rosette pores wide.

All ventral plates are separated by cuticular membrane (Fig. 2). Rosette pores are present laterally nearer the I and II coxal prominences of anteroepimeral plate (AE). The AE bears 3 pairs of setae and posteroepimeral plate (PE) 3 ventral and 1 dorsal seta. Genitoanal plate (GA) with paragenital areolae. Genital opening (GO) guarded by a pair of sclerites which bear a pair of subgenital setae (SGS) anteriorly. Three perigenital setae (PGS) are present on each side of the GO.

Gnathosoma stout and short, sculptured with rosette pore ventrolaterally and canaliculi ventromedially. Tectum is long. A pair each of proto -, deuto -, trito-, and basirostral setae present on gnathosoma (Fig. 3). Palp 4-segmented.

Rostrum extending upto two thirds the length of palpal telofemur. Palpal trochanter and patella devoid of setae. Palpal telofemur bears one dorsal seta and the palpal tibio-tarsus with 3 basal setae, besides one distal eupathidia.

Chaetotaxy of the legs I-IV is as follows:-

Trochanter 1-1-1-1, Basifemur 2-2-2-2, Telofemur 5-5-2-2, Patella 4-4-3-3, Tibia 7-7-5-5. Chaetotaxy of tarsus is discussed in the text.

Telefemorae III and IV are devoid of ventral seta. Tibiae I and II bear 3 ventral setae (one hair-like and the other two pectinate) besides 4 dorsal setae (Figs. 4, 5). Tarsus I bears 3 dorsal setae, one solenidion, one profamulus besides three ventral setae (one filiform basally, two singlet eupathidia distally) and 4 PAS (two doublet eupathidia). Tarsus II with 3 dorsal setae, one solenidion and 2 PAS. Tarsi III and IV with 3 dorsal fossary and one proximodorsal seta besides two PAS (one singlet eupathidia, one scaliform seta) (Figs 6, 7).

All legs bear two lateral claws and one bidentate median claw. Lateral claw of leg I is smooth ventrally with an accessory tooth dorsally. Lateral claws of legs II, III and IV bear an accessory tooth dorsally and are pectinate ventrally.

With the present record, the distribution of the species is extended into the Indo-Pacific region. The species occurs both in the Philippines and Indian coast in the shallow coral reef region.

I thank Dr. Ilse Bartsch, Biologische Anstalt Helgoland, Hamburg, Germany for encouragement.

July 14, 1997

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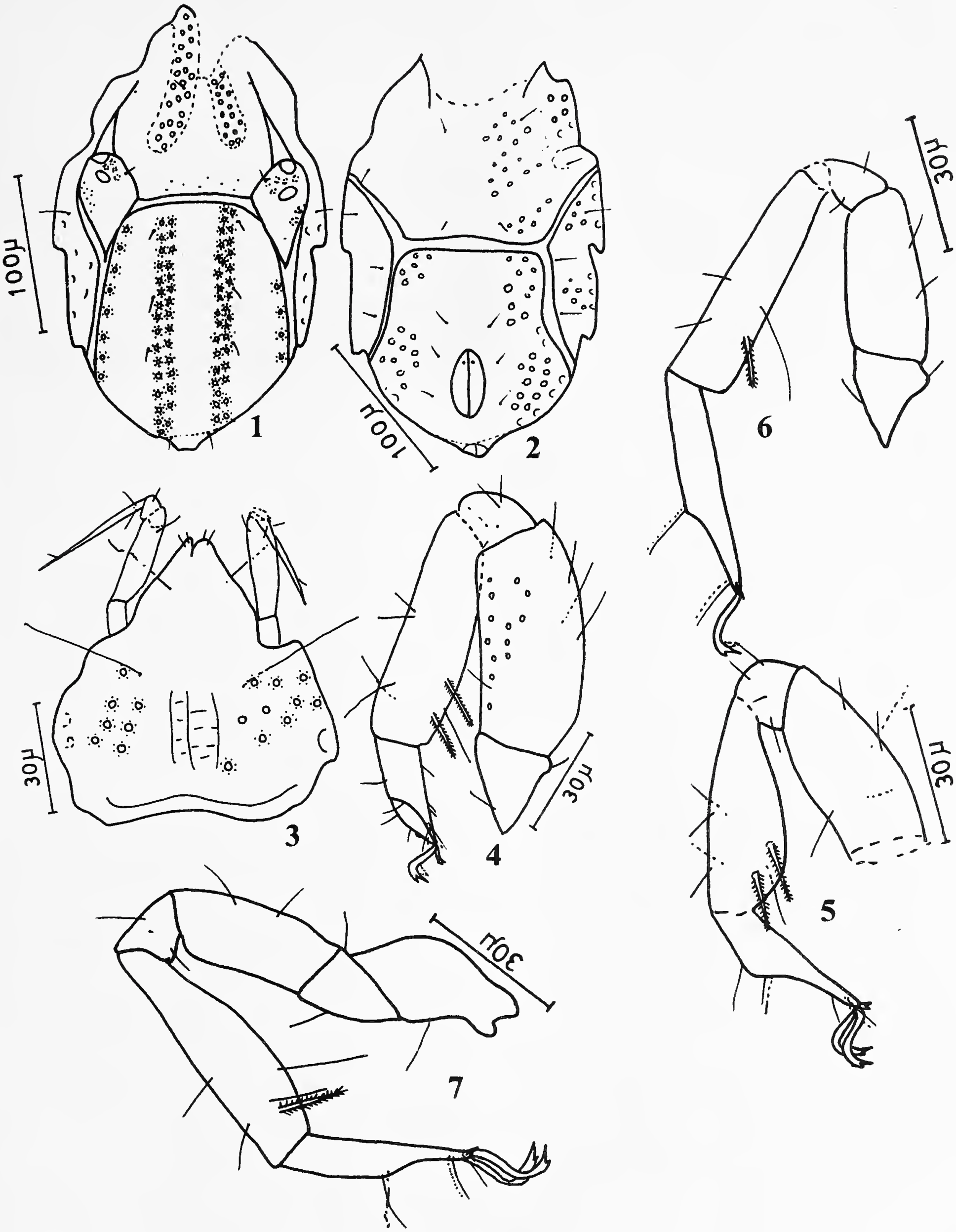

Figs. 1-7: *Copidognathus faubuli* Bartsch: 1. Idiosoma dorsal of female; 2. Idiosoma ventral of female; 3. Gnathosoma; 4. Basifemur - Tarsus of leg I; 5. Telofemur - Tarsus of leg II; 6. Basifemur - Tarsus of leg III; 7. Leg IV.

Reference

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34. RANGE EXTENSION OF *NEOCANCILLA CIRĊULA* (KIENER 1838)

(*With one text-figure*)

The family Mitridae is well represented along the Indian coast. Cernohorsky (1976) classified four subfamilies of Mitridae based on radula and shell characters. Subba Rao and Dey (1984) gave an excellent review of Indian mitrids, with their distribution. Most of the data on distribution is, however, very old.

Neocancilla circula (Kiener 1838), formerly *Mitra circula* Kiener 1838, was recorded from the south to southeast coast of India along Pamban, Chennai (= Madras), and Andaman and Nicobar Islands (Gravely 1942, Satyamurti 1952, Subba Rao and Dey 1984). None of these mention its occurrence along the west coast. A few references to molluscan fauna along the west coast are available (Melvill and Abercrombie 1893, Subrahmanyam *et al.* 1952, Menon *et al.* 1961), but none of these mention *N. circula.*

A specimen of *N. circula* was collected from Sasvane, Alibag (Maharashtra) during 1991-92. Subsequent surveys revealed its wide distribution on the west coast extending from Okha (Gulf of Kutch) to Malvan (Konkan coast, Maharashtra). The species has also become established along the Mumbai coast since 1992. Fifty transects in 1991 revealed 78 individuals, while a transect study in 1996 recorded 635 individuals from the study site.

Habitat: The species prefers rocky shores covered abundantly with silt or mud, but it is also found on sandy shores and mangroves.

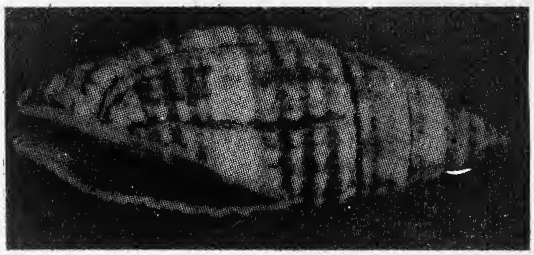

Fig. 1: *Neocancilla circula* (Kiener 1838)

Description: The shell is thick and spirally ridged. Upper whorls bear three spiral ridges, while lower whorls bear more than three. The outer lip is crenulated. The height of the shell is double or slightly more than that of the aperture. Columella bears three strong folds, of which the uppermost is the strongest. Subba Rao and Dey (1984) mention that the columella of *N. circula* bears four folds while Satyamurti (1952) records three. In this study of 500 individuals, the columella in all the specimens bears three folds, thus agreeing with Satyamurti (1952).

The average measurement of the shell is 42.1 mm in length and 20.0 mm height of aperture.

July 31, 1997

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35. THE GIANT AFRICAN LAND SNAIL *ACHATINA FULICA* BOWDICH IN NEPAL AND BHUTAN

The giant African land snail (*Achatina fulica*) is a serious agrihorticultural pest in most Indo-Pacific islands (Mead 1961, 1979; Raut and Ghose 1984, Raut 1992, Srivastava 1992). Being native to Kenya, East Africa, these snails were available in islands adjacent to East Africa around 1800 AD. W.H. Benson, a conchologist, brought a pair of live adult *A. fulica* specimens from Mauritius and released them in the Chowringhee Garden, Calcutta in 1847. Within a few years, they were common in parts of Bengal and Bihar. They are now very common in most Indian States (Raut and Ghose 1984), Bangladesh, Nepal and Bhutan. The status of *A. fulica* in Bangladesh was reported by Jahan and Raut (1994), but information on these snails from Nepal and Bhutan is wanting. This note is a report on the present status of *A. fulica* in Nepal and Bhutan.

In Nepal, *A. fulica* is common to abundant in almost all possible niches of Birat Nagar, Jaleshwar and Birgunge. In Bhutan, Samchi, Phuntsoling and Chirang are infested by these snails. It is said that these snails have invaded these countries from the adjacent snail-infested areas of India and become established over the past 6 to 7 decades.

The snails are nocturnal. They feed on vegetable crops viz. gourd, lettuce, cabbage, bean, etc.; fruit plants viz. papaya and cucumber and ornamentals marigold, chrysanthemum and American life plant. By feeding on these, they damage the crops seriously. Kitchen gardens and flower gardens are seriously threatened. Though the degree of damage is influenced by the snails' density, the seedlings of preferred food-plant species are never spared.

With the onset of monsoon they come out of their hiding places and start breeding. In Nepal and Bhutan, countries, breeding starts by May and continues upto early November. In all these countries, the rate of egg laying is higher during the first three-month period and the population density gradually increases during the last three months of the active period. During September-November they become a serious nuisance and health hazard. They are so numerous that every day a person must collect a few dozen snails from the walls, doors and lawn of his house, so as to keep the premises clean. Besides, it becomes practically impossible to walk on the road or drive a car at night, without crushing the crawling snails. Many of them are found crawling on the water supply or tube-well pipes, or on water tanks, thereby contaminating drinking water.

To date, no effective control measure has been found. Common salt is sometimes applied on the moving snails. Bandicoot rats are seen to feed on these snails, but it is not known whether the rats prefer the snails' flesh or feed on them only under compulsion.

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36. LECTOTYPIFICATION OF THE HYBRID *ATHYRIUM* x *KERALENSIS* MANICKAM & IRUDAYARAJ (ATHYRIACEAE, PTERIDOPHYTA)

Athryium x *keralensis* Manickam & Irudayaraj (1992) is an interspecific hybrid of *Athyrium puncticaule* T. Moore and *A. solenopteris* (Kunze) T. Moore. It was described as a new hybrid based on a single gathering from Kurusumalai (1000 m), Kerala. A detailed description and illustration have been given by Manickam and Irudayaraj (1992) in their book PTERIDOPHYTE FLORA OF THE WESTERN GHATS, SOUTH INDIA (B.I Publications, New Delhi). Unfortunately it was not typified. Hybrids are largely governed by the same rules as species by ICBN. As per the rules it is lectotyped here. There is a single herbarium sheet which has been entered in the field book of Rapinat Herbarium, Tiruchirapalli (RHT 33588) and preserved in St. Xavier's College (XCH), Palayamkottai. It is selected here as the lectotype of the hybrid.

Athyrium x *keralensis* Manickam & Irudayaraj [*Athyrium solenopteris* (Kunze) T. Moore x *A. puncticaule* T. Moore] PTERID. FL. W. GHATS S. INDIA, 238, Pl. 185 (1992).

Lectotype: S. India, Kerala, Kurusumalai (1000 m) Manickam, RHT 33588 (XCH!)

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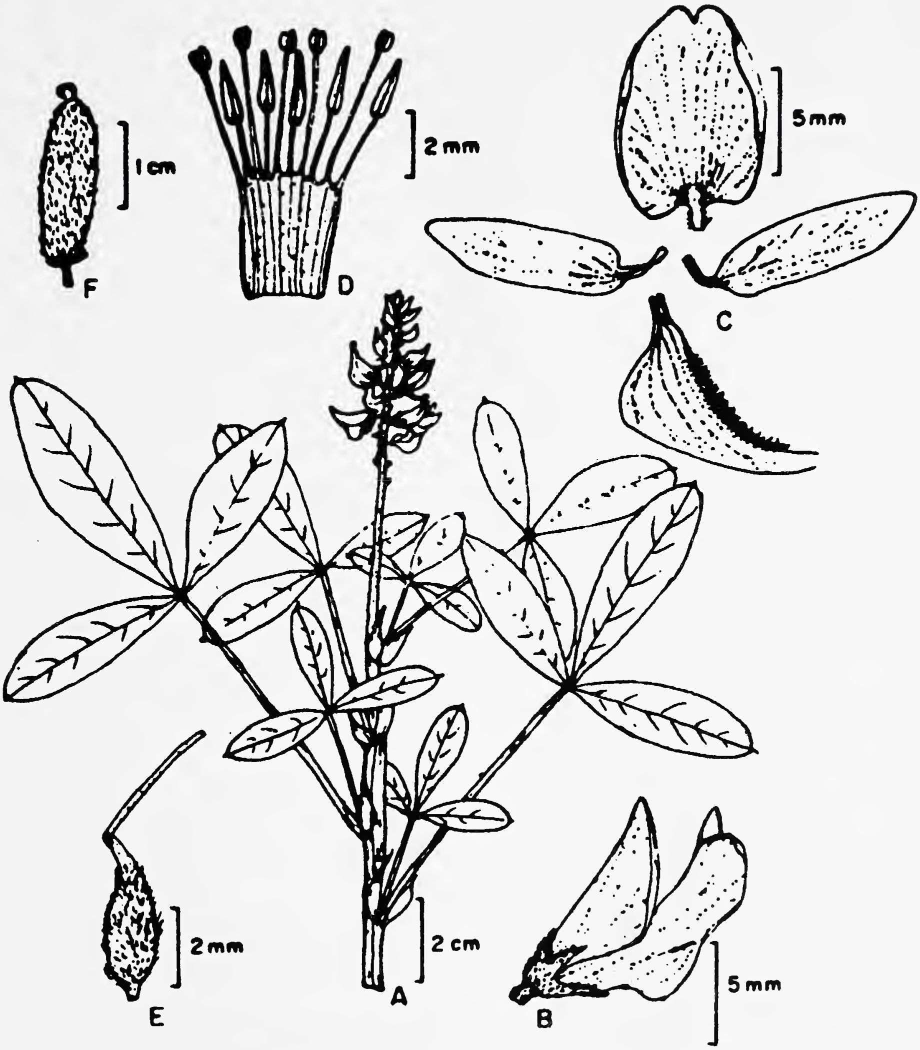
37. *CROTALARIA GOREENSIS* GUILL. & PERR. (LEGUMINOSAE) A NEW RECORD FOR INDIA

(*With six text-figures*)

While investigating the flora of Dakshina Kannada dist. of Karnataka, I came across an interesting, adventive species of *Crotalaria* near Padubirdi, Udupi Taluka, along roadsides. After a critical study, it was identified as *C. goreensis* Guill. & Perr., a tropical African species. Since there is no report of the species from India, a brief description and illustrations are provided below.

Crotalaria goreensis Guill. & Perr., Fl. Seneg. Tent. 165. 1832; Thulin, Legumi. Ethiopia. - Opera Bot. 68: 162. 1983.



Figs. A-F: *Crotalaria goreensis* Guill. & Perr.: A. Flowering branch; B. Flower; C. Petals: D. Stamens; E. Pistil; F. Pod.

C. macrostipula Steud. ex A. Rich., Tent. Fl. Abyss. 1: 153. 1847. *C. goreensis* subsp. *macrostipula* (Steud. ex. A. Rich.) Bak. f. in Journ. Linn. Soc., Bot. 42: 413. 1914.

An annual herb; 0.5 - 2.5 m tall; stem densely pubescent with appressed hairs. Leaves digitately 3-foliate; petioles up to 8 cm long; leaflets up to 8.5 x 2.5 cm, oblanceolate to obovate, sparsely appressed pubescent beneath; stipules 0.9-2.5 x 0.3-0.7 cm, oblong - falcate. Racemes terminal, up to 6 cm long, many-flowered, dense, elongating in fruit. Calyx 4-5 mm long. Petals yellow, with prominent reddish veins; standard *ca* 0.9 x 0.6 cm; wing *ca* 1 x 0.3 cm; keel *ca* 0.9 x 0.5 cm, with a distinct straight beak. Pods 1.5-2.0 x 0.7 - 0.9 cm, subsessile, pubescent, 12-16 seeded. Seeds smooth.

Specimens examined: INDIA - Karnataka State, Dakshina Kannada dist. Near Padubidri, 21.ix.1996 K.G. Bhat 11013 (BSI & K)

This species is similar to *C. pallida* Aiton but differs in having prominent stipules.

I thank Sri Krishna Murti, Indian Botanical Liaison officer, Kew, for examining the specimen and for valuable comments; and Dr. S. Karthikeyan, Botanical Survey of India, Pune for help.

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38. A NEW RECORD OF THE GENUS *MOLINERIA* COLLA (HYPOXIDACEAE) FOR THE STATE OF MAHARASHTRA

(*With one plate*)

During a botanical excursion to Eastern Maharashtra, some sterile specimens of Hypoxidaceae were collected from a place named Daldalkui in Bhandara dist. on November 4, 1995. In the absence of flowering and fruiting, the specimens could not be identified at that time. They were brought to Shivaji University and planted in earthern pots, where they flowered in October, 1996. They were identified as *Molineria trichocarpa* (Wight) Balakr., which forms a new specific and generic record for the state of Maharashtra. A full description, citation and photographs are, therefore, included in the paper.

The Indo-malayan genus *Molineria* Colla comprises about 7 species (Willis 1973) distributed in Tropical Himalaya, Eastern India, Tamilnadu, Andaman and Nicobar Islands, Sri Lanka and Malaysia. In India, it is represented by three species, namely *M. capitulata* (Lour.) Herb., *M. latifolia* (Dryanad.) Herb. and *M. trichocarpa* (Wight) Balakr. (Karthikeyan *et al.* 1989). The genus is closely allied to *Curculigo* Gaertn. but differs in the following characters:

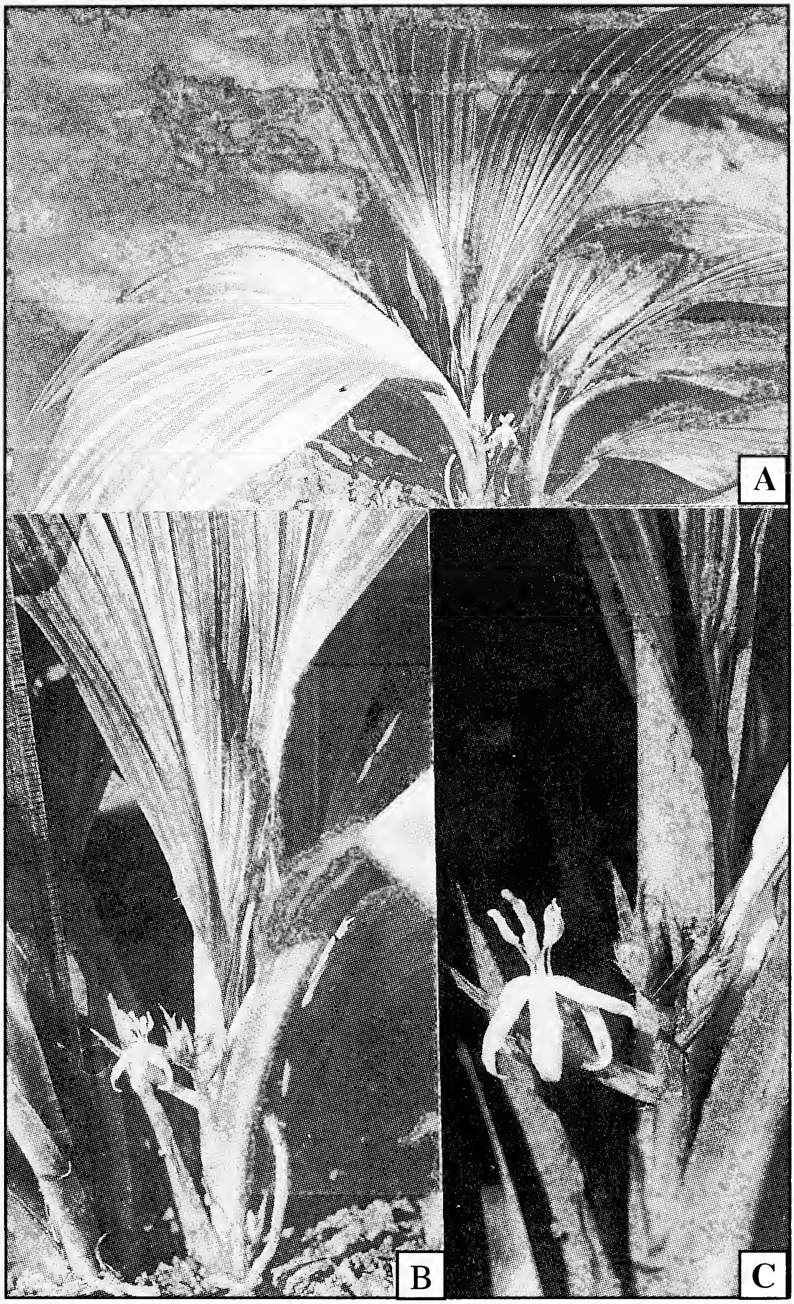
Perianth tube produced beyond ovary; stamens perigynous; flower(s) 1 or 2; style trilobed; bracts broadly lanceolate, overlapping, 9-nerved, glabrous; petiole less than 3 cm long; seeds beaked .... *Curculigo*

Perianth tube not produced beyond ovary; stamens epigynous; flowers 5-8; style not lobed; bracts filiform, linear, distant, 1-nerved, pilose; petiole upto 25 cm; seeds not beaked .... *Molineria*

Molineria trichocarpa (Wight) Balakr. in J. BOMBAY NAT. HIST. SOC. 63: 330. 1966; *Hypoxis trichocarpa* Wight, Icon. Pl. Ind. Orient. t. 2045. 1853; *H. latifolia* Wight. l.c.t. 2044.1853; *H. leptostachya* Wight, l.c.t. 2045.1853; *Curculigo trichocarpa* (Wight) Bennet and Raiz. in IND. J. FOR. 4:68.1981; *Molineria finlaysoniana* Wall. ex Baker in J. LINN. SOC. 17:121.1878; *Curculigo finlaysoniana* (Wall. ex Baker) Hook.f., FL. BRIT. INDIA 6:279.1892; Fyson, FL.S. IND. HILL STAT. 602.1932.

A perennial herb with thick fibrous roots; rhizome erect, stoloniferous. Leaves broadly lanceolate, 20-40 cm long; petiole 3-7 cm long, sheathing at base, channelled; leafblade 15-30 x 3-9 cm, plicate, glaucous, up to 20-nerved, base narrowed, apex gradually acuminate. Scape axillary, solitary, 3-6 cm long: racemes 4-5 cm long, 5-10 flowered: bracts 20-25 mm, linear, pilose. Flowers yellow, regular, lower bisexual, upper male, pedicellate; pedicels 1-1.5 cm, pilose; perianth lobes 6, yellow, 9-10 x 2 mm, outer ones pilose outside, inner ones glabrous; stamens 6, upto 7 mm long; filaments up to

Yadav S.R. & Bhuskute S.M.: *Molineria trichocarpa* PLATE 1



Figs. A - C: *Molineria trichocarpa* (A) Plants under cultivation; (B) Closeup of flowering plant; (C) Closeup of raceme and flower.

4 mm long, erect, glabrous; anthers basifixed, up to 3 mm long, yellow, introrse; ovary 3-celled, ovules many, style 9-10 mm long, thickened and hairy towards apex, stigma capitate. Fruits not seen.

Flowering: Under cultivation, it flowered in October.

Remarks: *Molineria* Colla grows along stream beds in shady places in forest areas. It forms dense local populations along stream beds. It looks very similar to *Curculigo orchioides* Gaertner in the vegetative stage. It was not reported from Maharashtra state, probably because of wrong identification as *C. orchioides* by previous workers.

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WILLIS, J.C. (1973): A dictionary of the flowering plants and Ferns. (8th ed. revised H.K. Airy Shaw). Cambridge Univ. Press. pp. 753.

39. ABNORMAL BRANCHING IN *BORASSUS FLABELLIFER* LINN.

We came to know from the students of a local college that a palmyra palm in the village Gollagonda, nearly 40 km away from Andhra University, had 7 branches, some of them also secondary branching. We visited the village and observed the plant. According to the villagers, the palm has been in existence for more than 40 years and earlier it had 15-20 branches, but some of those branches broke due to high wind. Now there are only seven branches. Among these branches, two branches have 2-5 secondary branches. The local people worship the plant and believe that it is a Goddess. Nearly 100 metres away from this plant, there is another bifurcated palmyra palm. One more plant in the nearby village of Nagaram has 4 branches, but due to recent cyclonic winds all of those branches were broken off.

According to Blatter (1926) branching is a rare phenomenon in palms. It is often caused by injury to the terminal bud, as in *Phoenix sylvestris* (wild date), where the apex is continuously tapped for toddy. Multiple branching in wild date due to the terminal bud being struck by lightning has been recorded by Field (1908). In other cases, branching is a consequence of the replacement of flowering buds by leaf buds which develop into shoots. According to the literature, lightning and injury of the terminal bud are responsible for multiple branching. But in the palm studied by us, the above two factors (lightning and terminal bud injury) may not be responsible for multiple branching. If branching is due to either apical bud injury or lightning, branching may not happen again — it is unlikely to be struck by lightning on 3-5 branches again. The factors, which are responsible for caudex stem branching, again those common factors are responsible for subsequent branching in some of those branches. Most probably, genetic factors may be involved in this branching.

We are thankful to Mr. Gandi Mahesh and Mahammed Tajuddin, students of Kalinga Junior College, for their kind help in field study.

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40. *SCHOENUS CALOSTACHYUS* (R. BR.) POIR., CYPERACEAE, FROM NICOBAR ISLANDS: A NEW SEDGE RECORD FOR INDIA

(*With one text-figure*)

While exploring the grasslands of the Nancowry group of islands, the author encountered an interesting sedge growing along open, damp, grassy slopes of Teressa Island, which turned out to be *Schoenus calostachyus* (R. Br.) Poir., a species hitherto unknown in India. As this is the first record for India, a detailed description, along with illustrations, is provided.

The genus *Schoenus* L. holds over 80 species (Kern 1974) distributed mainly from southeast Asia, Australia, New Zealand, New Caledonia, Micronesia, Europe, South America and Malesia. Karthikeyan *et al.* (1989) refers to one species, *S. nigricans* L., as occurring in Northwest India. *S. calostachyus* (R.Br.) Poir, is so far known only from Australia, Micronesia to Indo-China, Thailand, Ryu Kyu Is., Sumatra, Malay Peninsula, Borneo and New Guinea.

Schoenus calostachyus (R.Br.) Poir. Encyc. Suppl. 2:251.1811; Kern, Fl. Males. 7:675.1974. *Chaetospora calostachya* R. Br. Prod. 233.1810. (Fig. 1).

Perennials with woody rhizomes. Culms tufted, erect, sub-terete, 50-100 cm high. Basal leaves tough, acuminate, 3-ribbed beneath, 2-3 mm wide, with purplish sheaths.

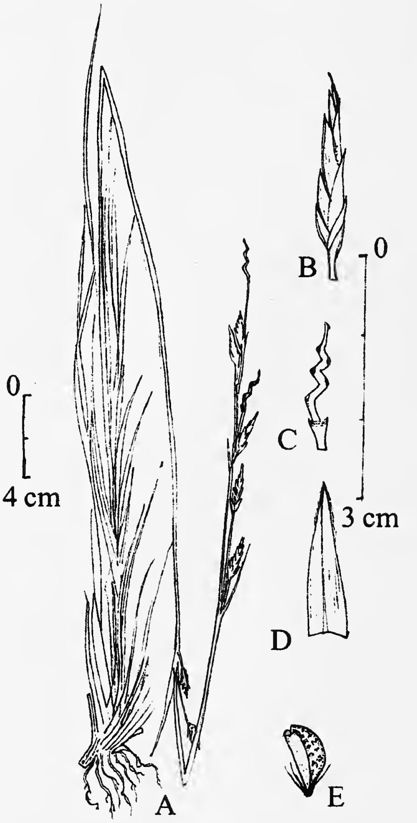

Fig. 1: *Schoenus calostachyus* (R. Br.) Poir.
A. Habit; B. Spikelet; C. Rachilla; D. Glume; E. Grain

Inflorescences narrow, racemose, up to 60 cm long with 2-6 distant fascicles of branches. Branches compressed, scaberulous on the angles, each holding 1-3 spikelets. Spikelets oblong-lanceolate or lanceolate, greyish-brown or chestnut brown, 20-25 mm long, 3-6 mm wide. Glumes lanceolate, brownish yellow to chestnut brown, shining, 8-15 mm long (fertile ones up to 20 mm long), coriaceous, ciliate on the upper margins. Nuts trigonous, oblique, 2 angles convex and the other straight, 2.5-3.5 x 1.5-2.0 mm, brown, rugose.

Ecology: Occasional in open grassland, heaths; usually in wet places, growing in clumps in association with *Sorghum nitidum* (Vahl) Pers., *Pachystoma senile* (Lindl.) Reichb. f., *Rhynchospora* sp. etc.

Specimen examined: Nicobar islands: Teressa Is., way to Enam from Minyuk, at ±2 km, 26.ii.1997, P.V. Sreekumar 16739 (PBL).

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41. ADDITIONS TO THE GRASSES OF GOA

The family Poaceae has attracted considerable attention due to its economic importance and diversity. However, the flora of Goa state has not been studied well due to its historical isolation, till 1961. The floras published on Goa (Dalgado 1898, Vartak 1966, Rao 1985, 1986) are not complete. Many species reported by them were collected outside the state of Goa. Recently Kulkarni and Janarthanam (1995) added 10 species of Scrophulariaceae to the existing published accounts. We report 24 additional grass species from Goa.

The identity of specimens was confirmed at BLAT, BSI and MH. The specimens are deposited at the Department of Botany Herbarium, Goa University.

1. ***Arthraxon lanceolatus*** (Roxb.) Hochst. var. *meeboldii* (Stapf) Welzen in Blumea 27: 285. 1981; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 401. 1996. Found in open areas of forests. Exsiccata: Surla, Alt. 460 m, 8.xi.1996, 309.

2. ***Chrysopogon lancearius*** (Hook.f.) Haines, Bot. Bih. Orissa 1036. 1924; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 431. 1996. On open laterite plateaus. Exsiccata: Goa University campus, 23.x.1996, 348.

3. ***Dicanthium filiculme*** (Hook.f.) Jain and Deshpande in Bull. Bot. Surv. India 20: 134. (1978) 1979; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 454. 1996. Found on cut surfaces of rocks and hillocks. Exsiccata: Molem, 22.xi.1996, 413.

4. ***Dimeria blatteri*** Bor in Kew Bull. 1949: 70. 1949; Lakshminarasimhan in Sharma *et al.*, Fl. Maharashtra Monocot. 467. 1996. Found along streams. Exsiccata: Surla, Alt. 460 m. 8.xi.1996, 339.

5. ***Dimeria ornithopoda*** Trin., Fund. Agrost. 167, t. 14. 1820; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 468. 1996. Found in marshy areas. Exsiccata: Keri, 16.x.1996, 231.

6. ***Eragrostis gangetica*** (Roxb.) Steud. Syn. Pl. Glum. 1: 266. 1854; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 483. 1996. Found growing in marshy areas, especially paddy fields. Exsiccata: Keri, 16.x.1996, 220.

7. ***Eriochloa procera*** (Retz.) C.E. Hubb. in Kew Bull. 1930: 256. 1930; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 494. 1996. Found in brackish water. Exsiccata: Courtalim, 14.xi.1996, 385.

8. ***Garnotia arborum*** Stapf ex T. Cooke, Fl. Pres. Bombay 2: 1013. 1908 (3: 534. 1967, repr. ed.); Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 497. 1996. On black boulders. Exsiccata: Molem-Almode road, Alt. 400 m, 28.ix.1996, 204.

9. ***Isachne elegans*** Dalz. in Dalz. & Gibs., Bombay Fl. 291. 1861; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 509. 1966. In cultivated fields. Exsiccata: Taleigao, 30.x.1996, 277.

10. ***Ischaemum dalzellii*** Stapf ex Bor in Kew Bull. 1951: 448. 1952; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 516. 1996. Along hillsides. Exsiccata: Chorla, Alt. 400 m, 8.xi.1996, 327.

11. ***Ischaemum kingii*** Hook.f. Fl. Brit. India 7: 129. 1896; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 519. 1996. On black boulders near water falls. Exsiccata: Chorla, Alt. 350 m, 8.xi.1996, 332.

12. ***Ischaemum mangaluricum*** (Hack.) Stapf ex C.E.C. Fischer in Gamble, Fl. Pres. Madras 1723. 1934; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 519. 1996. On plateaus. Exsiccata: Goa University campus, 14.viii.1996, 22.

13. ***Ischaemum timorense*** Kunth, Rev. Gram. 1: 369, t. 98. 1830; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 527. 1996. Along the roadsides of Ghat areas. Exsiccata: Surla, 8.xi.1996, 312.

14. ***Leersia hexandra*** Swartz. Prodr. Veg. Ind. Occ. 21. 1788; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 534. 1996. In ponds and marshy areas. Exsiccata: Ciba, Old Goa, 4.i.1997, 465.

15. ***Leptochloa malabarica*** (L.) Veldk. Blumea 19: 64. 1971; Nowack in Rheedea 4: 84. 1994. Usually in brackish waters (*Kazan* lands). Exsiccata: Courtalim, 14.xi.1996, 380.

16. ***Mnesithea clarkei*** (Hack.) Koning and Sosef in Blumea 31: 290. 1986; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 538. 1996. Along open hillsides. Exsiccata: Chorla, Alt. 400 m, 8.xi.1996, 331.

17. ***Oryza rufipogon*** Griff., Notul. 3: 5. 1851; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 545. 1996. Puddles on plateaux. Exsiccata: Lolium plateau, 24.viii.1996, 76.

18. ***Panicum hippothrix*** K. Schum. in Engl., Pflanzenw. Ost.-Afr. c. 103. 1895; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 548. 1996. In marshy, cultivated fields. Exsiccata: Taleigao, 13.ix.1996, 156.

19. ***Panicum walense*** Mez. in Bot. Jahrb. 34: 146. 1904; Lakshminarasimhan in Sharma *et al.* FL. MAHARASHTRA MONOCOT. 555. 1996. In cultivated fields. Exsiccata: Keri, 16.x.1996, 244.

20. ***Paspalum canarae*** (Steud.) Veldk. var. *fimbriatum* (Bor) Veldk. in Blumea 21: 72. 1973; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 558. 1996. An undergrowth of forests. Exsiccata: Surla, 8.xi.1996, 306.

21. ***Sacciolepis indica*** (L.) A. Chase in Proc. Biol. Soc. Wash. 21: 8. 1908; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 584. 1996. Common in ponds and marshy areas. Exsiccata: Carambolim lake, 2.xii.1996, 443.

22. ***Setaria pumila*** (Poir.) Roem. & Schult., Syst. Veg. 2: 891. 1817; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 595. 1996. On open lateritic plateaux. Exsiccata: Verna plateau, 17.viii.1996, 42.

23. ***Spodiopogon rhizophorus*** (Steud.) Pilger in Engl. and Prantl, Pflanzenf. Aufl.

2. 14e: 119. 1940; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 608. 1996. Open slopes of hills. Exsiccata: Chorla, Alt. 400 m, 8.xi.1996, 328.

24. ***Sporobolus virginicus*** (L.) Kunth. Rev. Gram. 1: 67. 1929; Lakshminarasimhan in Sharma *et al.* Fl. Maharashtra Monocot. 615. 1996. Along sandy beaches. Exsiccata: Miramar beach, 31.viii.1996, 109.

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December 24, 1997

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NEW DESCRIPTIONS

REVIEWS

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BIRDS

Cover Photograph: Great Indian Bustard
Asad R. Rahmani

Editorial

In December 1978, a party of Arab falconers crossed over from Pakistan to hunt Houbara bustard *Chlamydotis undulata* in the Thar desert of India. The news was first published in the Rajasthan Patrika, and then the Indian Express splashed it all over India. For most people, bustard means the Great Indian Bustard *Ardeotis nigriceps*, a highly endangered species. The statement of the hunting party that it had come to hunt (Houbara) bustard caused further confusion, as a result of which the whole country was wrongly informed that the Government of India had allowed royal falconers to kill the Great Indian Bustard, or *Godawan* as it is called in the Thar. The first public protest was organised by Mr. Harsh Vardhan, Hon. Secretary of the Tourism and Wildlife Society of India (TWSI). Soon, public and media condemnation became widespread. Protest rallies at Jaipur, Udaipur and Delhi, angry protest letters and erudite editorials in newspapers, harassment of the hunting party and government officials by intrepid reporters, and finally a stay order by the Jodhpur High Court, forced the Central government to cancel the hunt and to request the 'guests' to leave the country. This hunting episode was a blessing in disguise, as it focussed attention on this beleaguered species.

The TWSI, foremost in the fight against Arab falconers, organised the first international conference on bustards at Jaipur in 1980, where it was revealed that the Great Indian Bustard survives in six states — Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh and Karnataka. In the 1980s, intensive studies were conducted by the BNHS, with funds provided by the U.S. Fish & Wildlife Service. On the recommendations of the BNHS, Andhra Pradesh declared a 6 sq. km dry grassland near Rollapadu village as a wildlife sanctuary. The Madhya Pradesh government declared two bustard sanctuaries — Karera in Shivpuri and Ghatigaon in Gwalior, and Maharashtra officially protected three talukas each in Ahmednagar and Solapur districts, in the form of a vast 8,496 sq. km bustard sanctuary!

Unfortunately, all this could not arrest the steady decline of this majestic Indian bird, chiefly because its grassland habitat was not properly protected from over-grazing, plantation of exotic species, lack of control on pesticide use, development of canals and other irrigation facilities, changes in land use pattern and expansion of agriculture. No bustard is left in Karera, and only 3 to 5 survive in Ghatigaon. A sugar mill now stands on a male bustard territory in Maharashtra. Meanwhile, poaching has become common in the Thar, thanks to the availability of all-terrain vehicles. The great Thar desert, the last bastion of the bustard, is under siege. In the Thar, the bustard still survives in many areas and enjoys tremendous sympathy of the local people. It is this sympathy which the BNHS is now tapping by conducting regular conservation awareness programmes. If this campaign succeeds, the booming display call of male bustards will be heard for many more years and they will be able to propagate their own kind in the grasslands.■

ASAD R. RAHMANI

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NOTES ON THE BREEDING PLUMAGE OF THE MALE BLACKBREASTED WEAVERBIRD *PLOCEUS BENGHALENSIS* NEAR HYDERABAD, ANDHRA PRADESH[1]

Aasheesh Pittie[2], Siraj Taher[3] and C. Tom Hash[4]

(*With 2 plates*)

Key words: breeding plumage, blackbreasted weaverbird, *Ploceus benghalensis*, Hyderabad, Andhra Pradesh, taxonomy

During a visit to ICRISAT Campus (Patancheru, Medak district, Andhra Pradesh) in August 1996, a breeding colony of blackbreasted weaverbirds was seen. This was the first record of these birds breeding in Andhra Pradesh. A closer look at the birds showed that all the males had white cheeks. This did not correspond to the normally known breeding plumage of this bird. A similar observation was made in another colony about 15 km from ICRISAT. This variant breeding plumage has occasionally been reported in earlier literature and some very old specimens (1863 & 1890) from northeast India are in the British Museum of Natural History. Not much thought has been given to this aspect of the bird's plumage. These variations in breeding plumage give rise to some interesting queries like hybridization with other weaverbirds, relationship of the disjunct populations and a need to study the breeding ecology and taxonomy of *Ploceus benghalensis*.

The blackbreasted weaverbird *Ploceus benghalensis*, an endemic of the Indian subcontinent, has been reported earlier from Hyderabad in 1985 (Pittie and Taher 1985). On August 25, 1996, two of us (A.P. and S.T.) were birding on the campus of ICRISAT, near Patancheru, Medak dist., when we spotted a colony of about 50 of these birds, nesting in short grass and bulrushes (*Typha* sp.), close to a colony of nesting bayas *Ploceus philippinus*. There were 15-20 nests of *P. benghalensis*, and construction was in full swing. Most of the males were in breeding plumage with the golden yellow cap and black breast band prominently visible. But there was something wrong with their faces! The illustration in the PICTORIAL GUIDE (Ali and Ripley 1983) just did not match the birds we were watching. In this book, breeding males are shown with brown cheeks, sides of neck and ear-coverts, whereas the birds we were observing had white feathers in those areas! And not just a few birds had this plumage, all breeding males had it. A sketch was made on the spot, and when compared with the text and illustrations in other books (Ganguli 1975), the discrepancy remained. We

[1]Accepted March, 1998.
[2]8-2-545 Road No. 7, Banjara Hills, Hyderabad 500034.
[3]2-B Atlas Apartment, Road No. 10, Banjara Hills, Hyderabad 500034.
[4]8-2-684/2, Road No. 12, Banjara Hills, Hyderabad 500034.

called up C.Tom Hash, who works on the campus and is a keen birder, informing him of our observations, and he replied immediately "But aren't they different!" Indeed they were. Additional breeding colonies of these birds were seen on September 8, 1996, comprising 45-50 nests, in flowering Sudan grass *Sorghum bicolor* patches and on peripheral vegetation (mainly Polygonaceae, Verbenaceae, Gramineae, Meliaceae, Faboidae and Compositae) about an open well in the same campus. Photographs of the birds were taken and sent to the Bombay Natural History Society for comparison with their collections. No matching male was found. Subsequently, 4 live birds (2 males and 2 females) were sent to the BNHS on September 18, 1996 for their collection. Observations of the breeding activity at ICRISAT continued until November 3, 1996, when 2 immature birds were observed near a colony of 26 nests of which 19 had tubes, which in some cases were *c.* 36 - 38 cm long. At least one nest had a large hole in its egg chamber region, indicating predation. After this, birds in breeding plumage were not seen during visits on December 1, 1996, January 19 and April 6, 1997.

The variant plumage was noticed once again during the breeding season of 1997, when on June 21, a colony of 13 nests was observed, of which 10 were under construction with fresh green vegetation. White cheeked males, some with a white collar on the hind neck, were busy at them. At least 2-3 birds were observed bringing yellow flowers from a nearby *Acacia* sp., and placing them at the base of the half completed egg chamber, behind the 'chin-strap'(see also Ambedkar 1972). A female also visited the colony while we watched, sending the males into paroxysms of display. On August 1, 1997, Suhel Quader surveyed the colony and found one nest with 4 eggs, one with 1 egg and a freshly hatched chick, one with 2 eggs and a fledgeling, one nest with 3 eggs, and one nest with 2 chicks with feathers. On August 10, 1997, this colony had 12 nests, of which 4 were under construction with green vegetation. Two of these nests were inspected by Suhel Quader and A.P. One of them had 4 white eggs, and the other had 2 (the remaining nests were not examined). Between 400 and 500 birds were observed within the ICRISAT campus by Suhel Quader, in June, July and August 1997. Some of these were trapped in mist nets, photographed (Plate 1, Fig. 1), measured and released. Their measurements are given below in Appendix I. Almost all males seen had white cheeks. Some males had the sides of the head white suffused with a wash of brown. During this time, the baya *P. philippinus* and streaked weaver *P. manyar* were also breeding, mostly in separate colonies except one case, where *P. philippinus* and *P. benghalensis* had a mixed colony, in which *P. philippinus* had constructed nests hanging from banana (*Musa* sp.) leaves, while *P. benghalensis* hung theirs from the interwoven leaves of bulrushes. Another flock of *c.* 30 birds was observed on July 27, 1997 by C.T.H. northwest of Golconda Fort, Hyderabad, which is at least 15 km away (as the crow flies) from the ICRISAT campus. Here too, all males had similar white feathers on the face. A colony of about 7-8 nests was under construction among typha reeds.

A preliminary literature survey by Dr. Kumar Ghorpadé (*in litt.* 14-9-1996) and Dr. S. Unnithan of the BNHS (*in litt.* 27-9-1996), revealed that Jerdon (1863) described the male blackbreasted weaver thus, "the cheeks, ear-coverts, and sides of the neck white, more or less suffused with dusky on the ear-coverts and throat". Oates (1883) wrote, "throat, cheeks and ear-coverts white, sullied with brown on the latter two parts". Murray (1890) described a breeding male as having "... cheeks, ear coverts, sides of neck and throat white, more or less suffused with dusky...". But surprisingly, Oates and Blanford (1889-98) state, "After the partial spring moult ... the chin and throat become whitish or whity brown, and the entire side of the head and neck become uniform brown ..." and Baker (1922-30) "sides of head and lores brown; chin and throat

Pittie, Aasheesh *et al.*: *Ploceus benghalensis* PLATE 1

C.I. HASH

Fig. 1 Blackbreasted weaverbird *Ploceus benghalensis* were trapped, measured and released.

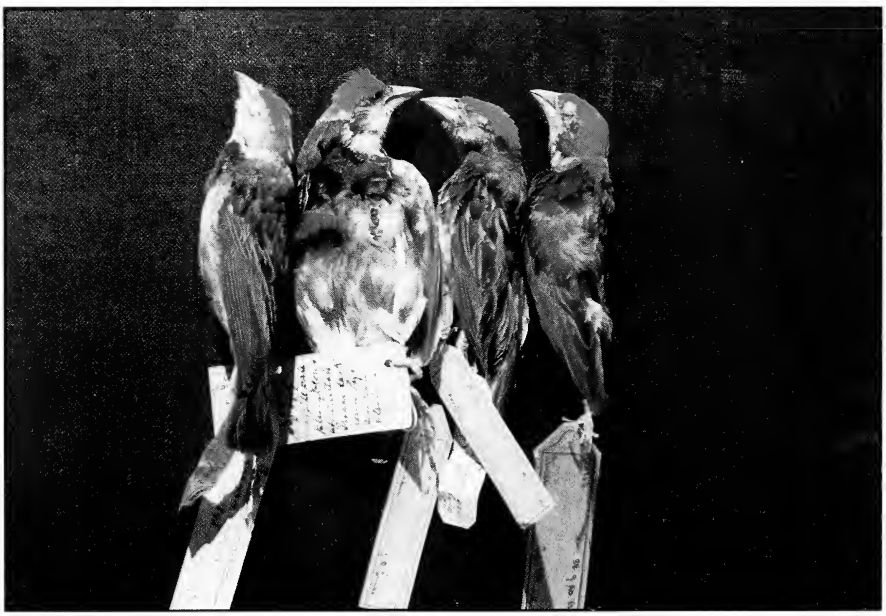
R. BHARGAVA/CWLO

Fig. 2: (left) Type A: Peak nuptial plumage; (right) Type B: Constituted 10-15% of total blackbreasted males.

Pittie, Aasheesh *et al.*: *Ploceus benghalensis* PLATE 2

R. BHARGAVA/CWLO

Fig. 3: Type C: Only one specimen was found of its type.



S. SUBRAMANYA

Fig. 4: Specimens from the British Museum of Natural History, Tring: four males in breeding plumage.

Appendix I

MEASUREMENTS OF *PLOCEUS BENGHALENSIS* MALES

Date (1997)	Time (hrs)	Sex	Wing (mm)	Tail (mm)	Tarsus (Right) (mm)	Bill Length (mm)	Bill Depth (mm)	Bill Width (mm)	Weight (gms)	Ring No.	Band Colour
21-6	0655	M br+	71	43	20.0	12.3	-	-	20.50	-	Red
21-6	0705	M br+	71	41	21.0	12.6	-	-	22.50	-	White
21-6	0900	M br+	72	45	21.5	12.9	-	-	23.75	-	Orange
21-6	0900	M br+	68	44	20.0	11.9	-	-	23.25	-	Dark Blue
21-6	0900	M br+	-	-	-	-	-	-	-	-	Light Green
15-7	0800	M br+	69	45	20.0	12.3	7.2	8.7	23.50	AB12 3680	-
17-7	0730	M br+	64	43	20.5	12.8	7.0	8.8	21.75	AB12 3690	-
18-7	0800	M br+	69	45	20.0	11.9	6.8	8.5	23.00	AB12 3698	-
18-7	1700	M br+	68	46	19.5	11.4	6.5	8.7	24.00	AB12 3700	-
18-7	1700	M br+	67	45	20.0	12.5	6.8	8.7	24.50	AB89 511	-
25-7	0900	??	69	44	20.0	12.6	6.8	8.5	22.25	Z4851 7	-
10-8	1010	M br+	68	44	19.5	12.8	6.9	8.2	24.00	Z48531 1	-

Notes

1. The first and second birds were measured by Siraj Taher. The rest by Suhel Quader.
2. Linear measurements are in mm. Flattened wing chord and tail from uropygial gland measured with a ruler to the nearest mm.
3. Tarsus measured to nearest 0.5 mm. (Joint of ankle to first complete scale from the claws).
4. Bill Length: length of upper mandible from front edge of nostril (to nearest 0.1 mm with Vernier callipers).
5. Bill Depth: Taken at front edge of nostril (to nearest 0.1 mm with Vernier callipers).
6. Bill Width: Taken at front edge of nostril (to nearest 0.1 mm with Vernier callipers).
7. Weight to nearest 0.25 gm with Pesola spring balance.
8. Colour bands on first 5 birds were put on their right legs.
9. Sex of penultimate bird could not be determined.

COMPARATIVE AVERAGE MEASUREMENTS OF *PLOCEUS BENGHALENSIS*

	WING	TARSUS	TAIL	WEIGHT
Handbook[1]	69-75 mm	*c.* 21 mm	38-45 mm	20 gms
Our Measurements[2]	68.73 mm	20.18 mm	44.09 mm	23 gms

1. Handbook Ali, S. and S.D. Ripley (1987)
2. Our measurements are averaged from 11 specimens.

whitish; in a few specimens, perhaps very old, the sides of the head and throat become practically pure white." Among more contemporary observations, Ali (1961), while watching a mixed colony of *P. manyar* and *P. benghalensis* in Bhurian village, Naini Tal dist., U.P., on July 8, 1961, noted "In male upper breast is a continuation or extension of the solid black of throat, but in some examples upper breast is incipiently, or even rather distinctly, streaked as in *manyar*."

Crook (1963), who studied the black-breasted weaver in the "Kumaon tarai," does not mention a white chin and throat in the breeding plumage of a male at all. Neither does he mention the presence of white cheeks, sides of neck and

ear-coverts. In fact, the black-and-white photograph in his paper (Plate II) of a male *P. benghalensis* clearly shows black feathers in these regions of its plumage. A white chin or throat is not visible, as the bird is perched with its back to the photographer, glancing sideways at the camera. The various line drawings also show breeding males with black feathers on their cheeks, sides of neck and ear-coverts. There is no trace of a white chin or throat in these illustrations! The HANDBOOK (Ali and Ripley 1987) is uncharacteristically ambiguous with "Below, whitish with a broad dark brown band across breast." Roberts (1992) states "In breeding plumage, the male is distinguished from the other two species of weaver found in Pakistan by having a continuous broad black band around the breast with a clear unmarked white chin and throat patch ... His lower neck and upper mantle are also solid black."

TABLE 1
DETAILS OF MALE *PLOCEUS BENGHALENSIS* SPECIMENS IN THE BRITISH MUSEUM

Regd. No.	88.9.20.626
Locality	Dinapur, Patna, Bihar.
Date of Collection	1865
Collector	Capt. S Pinwill
Plumage description	Throat white, cheeks partially white, ear coverts dusky suffused with white.
Regd. No.	87.7.1.1752
Locality	Monghur (*sic* Monghyr), Bihar
Date of Collection	July 1873
Collector	Not mentioned (Hume Collection)
Plumage description	Throat white; cheeks, ear coverts & neck brown with a few specks of white on ear coverts.
Regd. No.	87.7.1.1742
Locality	Muddeuderry, Dhobaghat, Fareedpur, Bengal (Faridpur, Bangladesh ?)
Date of Collection	18-6-1878
Collector	J R Cripps
Plumage description	Throat & cheeks white, specks of white on brown ear coverts, sides of neck (below ear coverts) white.
Regd. No.	1949.Whi.1.10.139
Locality	Baghobahar, Cachar, Assam
Date of Collection	?
Collector	A M Primrose ?
Plumage description	Throat, cheeks, ear coverts and sides of neck (below ear coverts) white.

Rajat Bhargava (*in litt.* 2-9-1997) observed the plumage of a minimum of 200-250 trapped "for bird release business" blackbreasted weavers in Meerut, Uttar Pradesh, during the breeding season of May-Aug, 1997 and says he found 3 types of plumages on males: A. Those "purely blackthroated or blackchinned with black breast and no white neck ring. This type, in relation to the other two types of blackbreasted weaverbirds, is not less than 85 to 90% (of the total population studied). This plumage, I believe was the peak nuptial plumage," (Bird at left, Plate 1, Fig. 2). B. Birds with a "black throat with small whitish chin not much visible unless handled, with no white ear coverts. This constituted about 10-15% of total blackbreasted males. I feel this may not be a separate variety, and possibly a stage just prior to or after the peak days of nuptial plumage, or it could be another type. This type closely resembles the plate illustration of the blackbreasted in Sálim Ali's PICTORIAL GUIDE," (Bird at right, Plate 1, Fig. 2). C. Birds with a "conspicuous prominent white chin or white neck ring and white ear-coverts," (Plate 2, Fig. 1). Of this type "I came across only one specimen as shown in the picture. This I feel is a separate type and the bird was in its full nuptial plumage."

On September 24, 1997, C.T.H. observed a male in breeding plumage among a small flock feeding on maturing pearl millet *Pennisetum glaucum* near Gwalior, Madhya Pradesh. This bird had plumage like that illustrated in the PICTORIAL GUIDE, with prominent white chin patch, black cheeks and black ear coverts.

While rummaging through some old black-and-white photographs, A.P. came across a picture of the birds from near Hyderabad taken in 1985, when they were first reported there. Four males can be seen in this photograph, and all four have the white-cheeked plumage described above!

There are, however, some interesting specimens in museum collections in Europe

and America. In the British Museum of Natural History (BMNH) at Tring, Dr. S. Subramanya (*in litt.* 9-10-1997) scrutinized these specimens and wrote "the collection has only four skins of males in breeding plumage (i.e. with yellow cap)." The details of the skins (all males) are given in Table 1. See also Plate 2, Fig. 2.

Dr. Pamela Rasmussen (*in litt.* 28-10-1997) mentions "two male *P. benghalensis* of the white-cheeked form." One, in the Yale Peabody Museum (YPM No. 43464), is from Darbhanga dist., Jaingar (*sic.* Jainagar), N. Bihar and was collected on 12-10-1898. The other, in the University of Michigan Museum of Zoology (UMMZ No. 177055), is from Assam. She writes "UMMZ also has two molting males from there that appear to be partially white-cheeked."

Discussion

Three published sources, from well over a century ago (between 1863 and 1890), report breeding male blackbreasted weavers with white feathers on their cheeks, ear-coverts and sides of neck. It is quite possible that Oates (1883) and Murray (1890) were quoting Jerdon (1863) in their works. Though Baker (1922-30) mentions that the throat and sides of neck turn practically pure white in some very old specimens, we think that this may not be a correct assessment for the birds studied by us, for the breeding population was quite large and certainly not all the breeding males would be "very old" specimens. Subsequent published literature is quite inconsistent in the description of a breeding male's head plumage. Some authors mention and illustrate a white throat and chin, others do not. None describe a black throat and chin. Neither do any refer to the white cheeks, ear-coverts and sides of neck described by ornithologists in the late 1800s. We wonder whether it is of any significance that the specimens in the British Museum, YPM and UMMZ, are all from east India and have either traces or a definite presence of white in their facial plumage, similar to the birds we observed here. Do *P. benghalensis* males have a different breeding plumage in different parts of the country (north India, and east and northeast India), which has escaped the scrutiny of ornithologists and taxonomists, or is their breeding plumage inconsistent due to some other anomalies? Should hybridization of *P. benghalensis* with either of the other two weavers be ruled out, as descriptions of the plumage pattern under discussion have already been published over a century ago? (see above). But at that time this bird was known only from northern and eastern India. Could there be a relation between the populations of east Indian birds and those found near Hyderabad, similar to other species of the Subcontinent that have a disjunct distribution in eastern and northeastern India and in the Eastern Ghats and Western Ghats, e.g. *Oriolus chinensis* (Abdulali 1949)? And now, a large majority of breeding males in Meerut (Uttar Pradesh State, northern India) have no trace of white on their chins, etc., these areas being dark brown in colour. We think that a serious look at the taxonomy of *Ploceus benghalensis* is called for, vis-à-vis the summer or breeding plumage of the males under consideration and those described in standard books to date.

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OBSERVATIONS ON THE DUGONG, *DUGONG DUGON* (MULLER), IN THE ANDAMAN AND NICOBAR ISLANDS, INDIA[1]

H. S. Das[2] and S. C. Dey[3]

(*With two text-figures*)

Key words: *Dugong dugon*, Andaman and Nicobar Islands, habitat protection.

The paper presents records of dugongs in the Andaman and Nicobar Islands. Morphological description of an adult female caught dead in a fishing net near Hut Bay in the Little Andamans is also given. It is concluded that the population of dugong in the islands, though not very high, is significant and can be conserved by protecting its potential feeding grounds.

Introduction

Situated between 6-14° N and 92-94° E, the Andaman and Nicobar Islands have large areas of seagrass, rich in diversity, which flourishes in clear, low-turbidity coastal waters. At least nine species of seagrasses belonging to six genera grow here (Das 1996). Fishes, turtles, crustaceans and echinoderms mainly use this habitat. Seagrass beds are also crucial for the highly endangered marine mammal, the dugong.

In the recent past, the urgent need to study the seagrass habitat and its associated animal life in Andaman and Nicobar Islands was felt by several workers (Silas and Fernando 1985, Rao 1990). Accordingly, a study was initiated by the Sálim Ali Centre for Ornithology and Natural History (SACON) to evaluate the habitat status, resource potential and conservation value of this ecosystem. The primary objective of the study was to identify the potential seagrass habitats for conservation, and information on dugong was also collected during the study.

Once widely distributed, the dugong *Dugong dugon* (Muller) has disappeared from many parts of its realm and is under serious threat in most of the remaining areas. In India, dugongs occur in the Gulf of Kutch, Gulf of Mannar, Palk Bay and Andaman and Nicobar Islands. Seagrasses being the staple food, the dugong is intimately associated with the seagrass habitat. Information on dugongs in the Indian subcontinent is available for Gulf of Mannar, Palk Bay and Gulf of Kutch. However, there are not many records such as photographs or morphometric descriptions of dead or live dugong from the Andaman and Nicobar coast. A photograph of a dead dugong from Diglipur area was published by Rao (1990) and a diapositive of a dugong caught dead near Hut Bay during March 1989 is available at Zoological Survey of India (ZSI), Port Blair (P. T. Rajan, pers. comm.). Besides, there are a few other reports (Bhaskar and Rao 1992, Rao 1990, James 1988, Jones 1980) which mention the presence of dugongs in the Bay Island.

Methods

The survey was undertaken, with the help of local fishermen and divers, from morning to evening around the seagrass habitats of the selected localities (Figs. 1 and 2) during 1994 and 1995 (pre- and postmonsoon periods). The sites were sampled randomly by snorkelling and diving, since there is no established method to estimate dugong population size accurately in the wild, except by aerial survey. Interview

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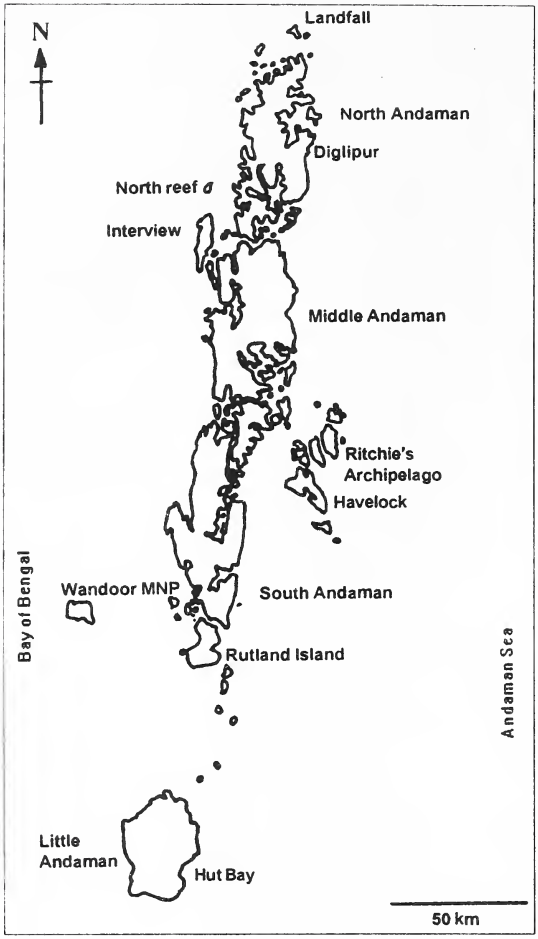

Fig. 1: Map showing survey locations in the Andaman Islands

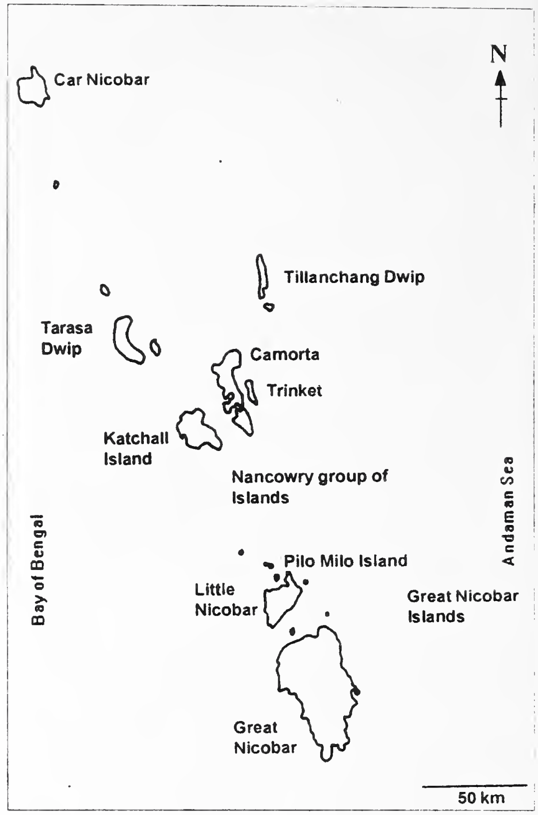

Fig. 2: Map showing survey locations in the Nicobar Islands

surveys were conducted to collect data on encounters and sightings of dugong in the coastal villages close to the survey area. As dugong poaching is illegal, the local fishermen were reluctant to share information. Hence, the interviews were done informally in several coastal villages covering various tribes, races and communities of the Andaman and Nicobar Is. The measurement of morphological features of a dead specimen at Hut Bay was done by one of the authors (Dey). Subsequently, we examined the complete skeleton.

Results and Discussion

Surveys by motor boat and rowing boat around Ritchie's Archipelago, North Reef, Marine National Park, Wandoor, and Diglipur during 1994 and 1997, and Little Andaman, Camorta, Pilo Milo, Little Nicobar and Great Nicobar Islands during 1995 and 1997 failed to locate dugongs in the wild. On several occasions, bones could be examined at Maya Bunder, Port Blair, Havelock, Hut Bay, Katchall and Camorta. The information gathered through interviews was very useful. Most of the tribes, namely the Andamanese, Onges and Nicobarese traditionally hunt dugong with iron harpoons tied to a boat (*dunghi*). Shompens have no knowledge of dugong hunting, hostile tribes (Sentinelese and

Jarawas) were not interviewed. Settlers, though they have no knowledge about hunting, at times get dugong in fishing nets close to seagrass beds. None of the tribes go for regular dugong hunting because of the time and effort it takes to catch one. The settlers from the mainland of India are mostly Hindus (Bengali and Hindi speaking) and do not like dugong meat as it looks and tastes like beef. Though there are no religious taboos preventing them from eating dugong meat, the settlers prefer fish. Hence killing is very often unintentional. To avoid legal problems, if an animal is caught dead in the fishing net, settlers/ non tribals hand it over to the tribes who are exempted from the Wildlife (Protection) Act, 1972.

TABLE 1
INTERVIEW SURVEYS ON DUGONG SIGHTING BY FISHERMEN AND DIVERS DURING 1990 - 1995.

Localities	People/ Tribes	Number of Dugongs reported
Andamans		
Landfall	Settlers	6
Diglipur	Settlers	*
North Reef Is.	No habitation	*
Ritchie's Archipelago	No habitation	6
Little Andaman	Settlers	5
Dugong Creek	Onges	5!
Strait Is.	Andamanese	*
Nicobar		
Katchall	Nicobarese	5
Camorta	Nicobarese	10
Little Nicobar	Nicobarese	4
Great Nicobar	Nicobarese Shompens	4

* sporadic sightings reported, but numbers not confirmed.
! As the distance between Hut Bay (Little Andamans) and Dugong creek is only 18 km in the sea, it is presumed that the same population of five animals cover both the areas.

The fishermen and regular divers had sightings of five dugongs on separate occasions between 1990 and 1994, along the north-western side of Camorta Island, five sightings near Dugong Creek and Hut Bay (five individuals), and four specimens each around Little Nicobar (Pilo Milo side) and Great Nicobar Islands. Moreover, around Ritchie's Archipelago, a group of five or six dugongs were seen by fishermen and divers on at least five separate occasions during 1990-1997 and six near Landfall island on regular basis. Thus, the number of dugongs living around the island groups are estimated to be around 40 (Table 1). However, a detailed study, preferably an aerial survey along the coast with expert help is essential to ascertain reliably the population size.

On February 19, 1997, a dugong was caught and brought dead to the shore at Hut Bay, Little Andamans. Since the net was laid 500 m offshore near the 11 km stop at 1700 h on February 18, 1997 and the animal was noticed dead in the net next morning at 0430 h, it must have got entangled and died any time during that period. Probably, the dugong had come to feed, as evidenced by the presence of surrounding seagrass patches and the stomach contents of the animal. When it was brought ashore, the Asst. Fisheries Development Officer (co-author of this paper) was informed. He reached the site immediately and prevented the fishermen from distributing the meat and bones. The dugong, an adult female (length: 2.63 m and weight: 250 kg), was buried under sand after recording morphometric details (Table 2). The complete skeleton was exhumed later and kept in the fisheries office at Hut Bay. The skeleton was examined in detail in May 1997.

Dugongs were common in the 1950s, but the population has dropped drastically in the recent past, as evidenced by sporadic sightings and rare records of poaching. The primary reason for this decrease in this island group is habitat loss, which has resulted from increasing heavy boat traffic, faulty land use practices such as conversion of forests to banana, areca nut and coconut plantations. Natural calamities like cyclones and high energy tidal storms may also be partly responsible. In fact, a wounded and dead dugong was noticed by Andaman Public Works Department workers near Pilo Kunji of the Great Nicobar Islands in July 1989 after a cyclone.

TABLE 2
MORPHOMETRIC DETAILS OF THE DUGONG CAUGHT DEAD IN A FISHING NET ON FEB. 19 1997 AT HUT BAY

Date of fishing	19.ii.1997 (Fishing net was laid at 5 pm on 18.ii.97 and the animal was found dead in the net on 19.ii.97 morning, fresh body)
Sex	Female (lactating)
Total length	2.63 m
Weight	250 kg
Perimeter at chest	1.8 m
Flipper size	42 cm x 53 cm
Snout to flipper	55 cm
Snout to eye	33 cm
Height of the body on ground	63 cm
Stomach content	semi-digested seagrass species.

This study concludes that dugongs are less abundant than in the recent past. Although their numbers are highly reduced and large populations are seen no more, dugongs still exist at least around Ritchie's Archipelago, North Reef, Little Andamans, Camorta (Allimpong, Trinket and Pilpilow), Little Nicobar and parts of the Great Nicobar Is. On the basis of the data collected, we propose that the following measures should be taken for the conservation of dugongs in the Andaman and Nicobar Islands: (1) initiation of environment education programmes in the coastal villages, (2) protection of potential dugong habitats and enforcing strict legislation to protect dugongs in and around their feeding habitats by restricting human activities such as fishing and trafficking, and (3) regular monitoring of the dugong population. The study also advocates the necessity of an aerial survey of dugong populations to determine its current status, and to undertake long term monitoring thereafter.

ACKNOWLEDGEMENTS

The paper is part of the project "Status of the seagrass habitats of the Andaman and Nicobar Islands" sponsored by the Ministry of Environment and Forests, Govt. of India. Help rendered by the Forest department and Fisheries Department of the Andaman and Nicobar Islands during the survey is gratefully acknowledged.

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■ ■ ■

ICHTHYOFAUNA OF ERAVIKULAM NATIONAL PARK WITH NOTES ON TROUT CULTURE IN RAJAMALAI, MUNNAR, KERALA[1]

K. Raju Thomas, C.R. Biju, C.R. Ajithkumar[2] and M. John George[3]

(*With five text-figures*)

Key words: Ichthyofauna, distribution, trout culture, Eravikulam National Park, Rajamalai, trout hatchery.

The status and distribution of fishes in the Eravikulam National Park, Kerala were studied. Only four species viz. *Garra hughi, Horalabiosa joshuai, Nemacheilus keralensis* and *Salmo gairdnerii*, belonging to three families were recorded from the Park. This may be due to high altitude, low water temperature and high gradient. Except for the exotic *Salmo gairdnerii*, these species are endemic to the southern Western Ghats, especially to southern Kerala. Some observations on of trout culture are included.

Introduction

Eravikulam National Park is situated in Idukki dist., Kerala. The Eravikulam Plateau and the adjacent areas in the high ranges of Kerala were the lease lands of the Kannan Devan Hills Produce Co. The Park is famous for sustaining the largest surviving population of the endangered Nilgiri tahr, *Hemitragus hylocrius*. This area was declared a Sanctuary in 1972. Because of its outstanding ecological, faunal, flora, geomorphological and zoological significance, the area was declared a National Park in 1978 (Nair 1991). The Park has extensive grasslands interspersed with evergreen shola forests. Eravikulam supports the largest population of the Nilgiri tahr in the world, a viable population that exists without human interference. Anamudi Peak (2694 m), the highest point south of the Himalayas falls in the southern parts of the Park.

Eravikulam National Park is located at 10° 8' N - 10° 19' N lat. and 77° 0' E - 77° 8' E long. and lies in Devikulam taluk of Idukki dist., Kerala. It is bounded by the old Kannan Devan Hills Produce village along the ridges through Kattumudi and Perumamalai in the east; northern boundaries of Chattamunnar, Nyamakad and Vaguvarai estates of Tata Tea Co. in the south; old Kannan Devan Hills Produce village ridges through Rajamalai, Sambamalai and Kolukkumalai in the west. The northern boundary coincides with the interstate boundary between Tamil Nadu and Kerala (Fig. 1). The average elevation of the park is 2000 m above msl. The main plateau is divided roughly in half from northwest to southeast by Turner's Valley. The park is criss-crossed by small perennial streams of Periyar and Pambar rivers, of which Periyar is a west flowing river while Pambar is an east flowing one. The average annual rainfall is 4800 mm: it is one of the wettest areas on earth. Perennial streams, wetlands and marshes increase the ambient water. The isolated sholas act like sponges, giving out water throughout the year.

Results of Faunal Survey:

Samples were collected during December, 1997 and February, 1998 to study the status and distribution of fishes in the streams of Eravikulam National Park. Fish sampling was carried out using cast nets, hooks and a modified form of cast net for small fishes. The specimens were preserved in 10% formalin. Only four species were collected from the Eravikulam National Park; all are typical freshwater fishes. Compared to the other National Park and

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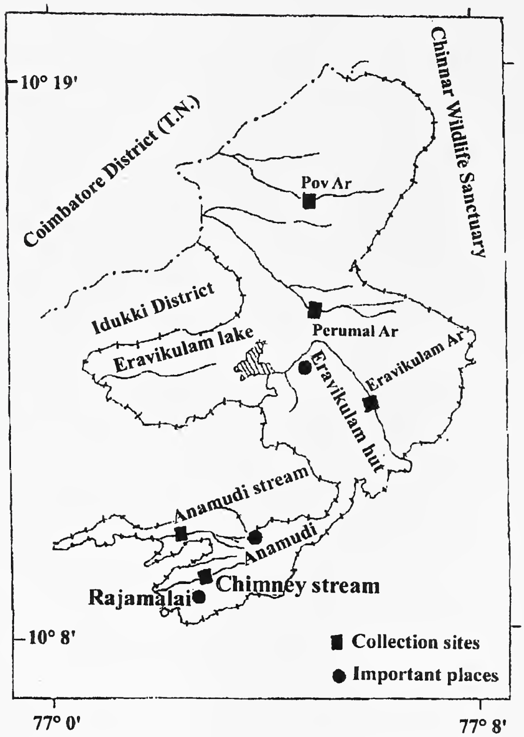

Fig. 1: Map of Eravikulam National Park showing various collection sites

Sanctuaries in Kerala, the fish diversity of Eravikulam National Park is much less. This may be due to high altitude, low water temperature and high gradient. All the streams, including the Eravikulam before the introduction of the Rainbow trout, *Salmo gairdnerii*, were full of an indigenous fish, *Glyptothorax madraspatanus*. This fish species was not represented in collections. The following species were recorded from the Park:

List of species (Figs. 2, 3, 4, 5)

Family: Cyprinidae

1. *Garra hughi* Silas
2. *Horalabiosa joshuai* Silas

Family: Balitoridae

3. *Nemacheilus keralensis* (Rita & Nalbant)

Family: Salmonidae

4. *Salmo gairdnerii* Richardson

1. *Garra hughi* was collected only from Eravikulam stream, a small tributary of Pambar river. It was originally reported from lower Vauguvarae estate, Travancore, Kerala br Silas)1954), in whose original description scales were absent on mid-dorsal streak. Recently Rema Devi observed that the type specimen does have scales on the mid-dorsal streak (pers. comm.). Our specimens also had scales on the mid-dorsal streak.

2. *Horalabiosa joshuai* was described by Silas (1953) from the head-waters of Tamraparni river at Singampatty in the Western Ghats of Tirunelveli dist. Tamil Nadu. Raju Thomas *et al.* (1999) have reported this species from Chinnar Wildlife Sanctuary area of Pambar river. This is the second report of this species from Kerala.

3. *Nemacheilus keralensis* was distributed in almost all streams inside the Park. So far it has been reported only from high altitude streams and is considered a typical hill stream fish. The type locality is Pampadampara, near Munnar, Kerala.

4. The Rainbow trout, *Salmo gairdnerii* was introduced into India from United Kingdom, New Zealand and Sri Lanka in 1869 (Talwar and Jhingran 1991). The young of *S. gairdnerii* were stocked in different streams of Eravikulam National Park and nearby reservoirs. They are now well established there.

Physical features of the habitat, viz. width, depth, substrate distribution, land use pattern, nature of water and flow rate were assessed at various collection sites. The water temperature ranged between 13°-18°C and is the most important factor for the survival of the above species, especially trout. During the sampling time the flow of water ranged between 20-25 cm/sec; width and depth of streams were less, i.e. 2-4 m and 10-25 cm respectively. Around most of the collection sites, there were tea and eucalyptus plantations and southern montane wet grassland with small patches of montane wet temperate

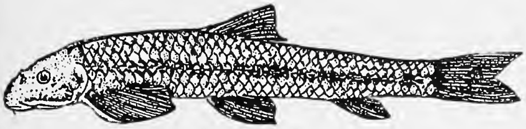

Fig. 2: *Garra hughi* Silas

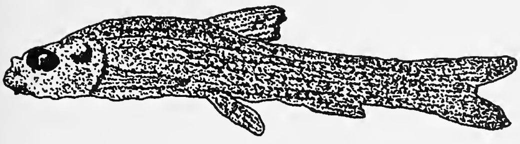

Fig. 3: *Horalabiosa joshuai* Silas

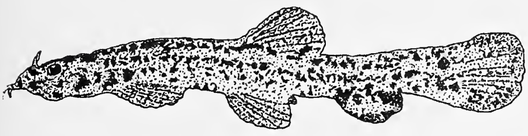

Fig. 4: *Nemacheilus keralensis* (Rita & Nalbant)

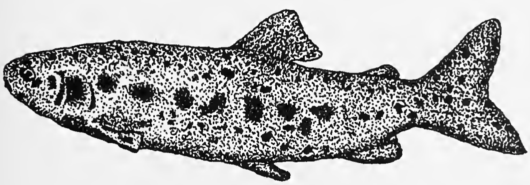

Fig. 5: *Salmo gairdnerii* Richardson

forests known as 'Sholas'. Water is almost clear in all the streams. Regarding the substratum, mud, sand and detritus were less compared to gravel, cobble, boulder and bedrock. The pH ranged around 6.9 and the DO values ranged between 6 and 7 ppm.

Trout culture in Rajamalai

Fish culture in the uplands of India began with the introduction of exotic fishes in 1899. The first ever hatchery for Brown Trout in India was made by Mitchell (Jhingran & Sehgal 1978). Artificial propagation of trout is practised to meet the stocking requirements of streams lakes and reservoirs for angling, and for food. A trout hatchery was established at Rajamalai, 20 km, from Munnar. This hatchery is still the mainstay of the High Range Angling Association. *Salmo gairdnerii* is cultured here.

Acceptable sources of water for a trout farm are springs, streams, rivers and lakes, of which spring water is considered ideal. Due to fluctuation in water temperature throughout the year, water from rheocrene (running) springs and limnocrene (located in depressions) springs are more suitable. There should also be moderate rainfall, moderate gradients, moderate foliage cover, uniform temperature, adequate limestone and other mineral deposits, absence of grazing, mining etc., provision of underground hatchery intake from source of water supply, provision of underground pipelines in the hatchery to minimise temperature changes, and covering of the water supply channels to prevent surface contamination (Jhingran and Sehgal 1978). In Rajamalai trout farm, the water is supplied by the Anamudi stream and almost all conditions mentioned above are maintained here. The optimum temperature ranges between 12°-16°C.

The spawning season of trout varies to with the temperature of the water. For rainbow trout, the spawning season is September to February. Rainbow Trout shows sexual dimorphism (Jhingran and Sehgal 1978), when the sexes attain maturity.

Prior to egg-taking the cock fish (males) and hen fish (females) are kept in separate tubs and the water is changed by fresh drawal from a stream. The egg-taking is done by applying gentle pressure on the belly of the fish. The released eggs and milt are transferred to spawning pans. This is followed by shocking, which is the process of hastening the whitening of infertile eggs, which are otherwise non-discernible, so that they can be removed quickly from the tray. The eggs are agitated to speed up coagulation, by stirring them in the hatching tray with bare hands or siphoning through a common garden hose. After the shock, dead eggs are removed with a pipette. This is called egg-picking.

After the trout eggs are water hardened and counted, they are transferred to a hatchery for incubation. In the Rajamalai hatchery, unpainted concrete is used as trough for incubation. The rate of trout egg development is dependent on water temperature. Incubating eggs pass through several stages of which four are well marked. They are: Green egg, Eyed egg, Sac-fry or Alevin and Swim-up fry.

Sanitation is very important in a trout hatchery. Fungal infection is the greatest foe of trout and is difficult to prevent it from spreading. To avoid this, dead eggs must be carefully removed from the tray every morning. A mixture of salt and potassium permanganate is used to prevent diseases in Rajamalai hatchery. Based on studies conducted in various parts of the world, the most satisfactory results are achieved with malachite green.

Ponds for rearing trout are of diverse sizes and designs. An ideal trout pond is deep with a little current most of the time, but can be readily converted into a shallow swift pond when necessary. The troughs being shallow, fry cannot be kept there for an indefinite period and hence the need to transfer them to nursery ponds. The usual size of a nursery tank in Rajamalai is 5 x 1 x 0.75 m. Once the fry have grown to fingerling size, they are transferred to larger growing ponds and raceways. A raceway is usually an elongated artificial body of water. A natural raceway is like an oblong trench with earth walls and bottoms. Each raceway can be connected to a series of other raceways.

One of the most important aspects of rearing pond management is to assess their carrying capacities in advance so as to determine stocking rates. Oxygen consumption and basal metabolic rate which a given water flow can support are crucial in estimating the quantity of fish in a hatchery.

Acknowledgements

We thanks the U.S. Fish and Wildlife Service and the Ministry of Environment and Forests for sponsoring the project on "Ecology of the hillstreams of the Western Ghats with special reference to fish community"; this paper is a part of the study carried out under this project. We thank Mr. J.C. Daniel, Honorary Secretary, Dr. Asad Rahmani, Director and Dr. B.F. Chhapgar of the BNHS for encouragement. We also thank Mr. Manoharan, C.C.F. Kerala Forest Department and Mr. Mohan Alampath, Wildlife Warden, Munnar for permission to enter the Park and for accommodation; Tata Tea Co. for permission to see the trout hatchery and for details regarding its culture practices.

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THE BIRDS OF GOA[1]

Heinz Lainer[2]

(*With one text-figure*)

Key words: ornithological survey, populations, Goa, breeding records, migration

This annotated checklist is the result of 13 years of intensive field study, including 1300 field trips, starting from 1980. The avifauna of Goa has been studied in terms of populations, number of sightings, migratory and breeding records if present. These have been compared with the records of previous decades, starting in 1972. The differences in the observations over these two decades have been discussed, to provide an overview of the avifauna of Goa.

Introduction

Little work has been done on Goa's avifauna. The Portuguese who ruled the tiny territory on India's West Coast from 1510 to 1961 were, unlike their British counterparts, less interested in birds as objects of scientific study than in their nutritious and culinary properties! This attitude seems to have rubbed off on their colonial subjects of 451 years, and is still prevalent.

In 1972, however, the Government of the erstwhile Union Territory of Goa, Daman and Diu commissioned the Bombay Natural History Society to conduct an ornithological survey. This led to a 16-day field trip by Dr. Sálim Ali and R.B. Grubh at the end of 1972. Work was almost entirely restricted to the belt of dense evergreen and moist deciduous forests along the Western Ghats, and consisted mainly of collecting specimens, resulting in the publication of a systematic list comprising 154 species (Grubh and Ali 1975). Ulhas Rane visited the same area thrice, for a couple of weeks altogether, in 1981-82 and added a further 33 species to this list (Rane 1982)

This annotated checklist is the result of 13 years of fairly intensive field studies and about 1300 field trips of both short and extended duration, commencing in 1980. The author, admittedly an amateur ornithologist, found his occupation an extremely lonely one, having never come across a birdwatcher of either Indian or foreign provenance over a span of nine years. However, with the advent of low-priced direct charter flights from Europe to Goa in the late eighties there is a rapidly growing number of mostly British birdwatchers visiting, usually for two or three weeks only. They are of the fast moving and competitive 'life list' type, generally well informed about India's avifauna, extremely keen and sharp-sighted. In their desire to notch up as many 'new' species as possible, in the very short time available, they frequently get carried away and tend to make blatant misidentifications which are then mirrored in the photocopied leaflets about their exploits that they publish, circulate, and sell among birdwatchers in Britain.

It was only recently when Gordon Frost, a knowledgeable, scrupulous field worker, settled in Goa that I was able to join forces with a fellow birdwatcher.

Geographical outline

Goa is a narrow strip of land 3,701 sq.km in area, 105 km long and up to 65 km wide. It is flanked by the Arabian Sea to the West and the Western Ghats (or Sahyadris) to the East. It lies between 15°48'00" N and 14° 53'54" N lat. and between 74°20'13" E and 73° 40'33" E long.

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Goa

Physical features and vegetation types

For an ornithological survey, Goa is most conveniently split into three main physical divisions, i.e., the coastal belt, the midland region and the Western Ghats.

1. The coastal belt: Goa's 133 km long coastline is characteristic of South Konkan, with its sandy bays, beaches and rocky headlands broken by the wide estuaries of the Mandovi and Zuari rivers and interspersed with minor estuaries. Behind the coast stretches a patchwork quilt of paddy fields, well-wooded villages, groves of coconut palms and evergreen leafy trees, creeks, saltpans, saline and freshwater marshes. Along the larger rivers, this coastal habitat extends into the interior as far as tidal influence reaches (over 40 km), forming inland bays of brackish and saline marshes. Over 2,000 ha of mangroves line Goa's creeks and estuaries.

2. The midland region: Central Goa consists by and large of lateritic plateaus 30-200 m high, with their outlying detached elements abutting in several places as headlands into the sea. They are covered with stunted cashew trees, thorny scrub and coarse grass, while the scarp-faces, especially the hollows and gullies, support patches and strands of remnant semi-evergreen forest. Numerous perennial springs feed intensive cultivation of areca, coconut, spice, fruit and paddy in the often terraced valleys. A good part of this region is indelibly scarred and irreversibly degraded by large scale open cast and strip mining of iron and manganese ore.

3. The Western Ghats: The Sahyadris in Goa extend in a 125 km long arc, with a crestline constituting the eastern border with Karnataka. About 600 sq. km in area, they have an average elevation of 800 m above msl, several hundred metres lower than the adjoining sections, thereby creating the 'Goa gap'. The northern part is of the Deccan trap type with horizontally layered vertical cliff-faces reminiscent of South Maharashtrian hill-stations like Amboli, while the southern and larger part consists of the rounded and densely wooded hills characteristic of the northern Uttar Kanara Ghats. Tropical wet evergreen forest occurs in strands and patches in the deeper valleys over about 200 sq.km. Tropical moist deciduous forests account for approx. 400 sq.km.

Climate

The maritime, monsoon type climate of Goa is equable and moist or humid throughout the year. Except for the monsoon season, it is temperate, with little demarcation between the cold and hot weather periods.

Annual rainfall is 250-320 cm along the coast and 510-760 cm on the higher slopes of the Ghats. Over 90% of precipitation occurs during the SW monsoon from June to September.

Seasonal variation in temperature is slight: May, the hottest month, has a mean daily temperature of *ca*. 30° C, January, the coolest, *ca*. 25° C. Due to the proximity of the sea, the diurnal range of temperature is not large (4-6° C during monsoon and 10-12° C in January-February).

Relative humidity is high, even during the dry season it is generally above 60%.

Conservation

Since Goa's liberation from colonial rule in 1961, several measures were taken by the government to protect wildlife, with varying results. During the decade after liberation, the most effective means of protection has proved to be the politically motivated unavailability of ammunition for the large number of firearms left by the Portuguese in the hands of the landed and affluent class.

In 1967, a 240 sq.km area of prime wet evergreen, semi-evergreen and moist deciduous forest on and below the slope of the Western Ghats was notified as the Bhagwan Mahaveer Wildlife Sanctuary (BMWS). This includes the Mollem, Collem and Dudhsagar areas largely covered by the previous ornithological

investigations. This sanctuary is still unspoiled, but is being increasingly opened up to government sponsored tourism which will ensure its degradation. Mammalian wildlife has recovered to an amazing degree from near non-existence at the end of the colonial era and since Grubh and Ali (1975) commented on its sorry state in the early seventies.

The Bondla Wildlife Sanctuary, a small area of 8 sq.km in a cluster of outlying hills, is an obvious misnomer. Detached from the main body of the Western Ghats, it features an abysmally ill-kept zoo, a botanical garden and an attached government-run tourist resort, making it one of Goa's favourite picnic spots but hardly a wildlife sanctuary. Though surrounded by extensive open cast iron mines, the moist deciduous forests beyond the sanctuary limits harbour a surprisingly rich birdlife typical of the middle section of the Western Ghats.

The Cotigao Wildlife Sanctuary at Goa's southern border to the Uttar Kanara district of Karnataka is 105 sq.km in size and consists of mainly riverine semi-evergreen and moist deciduous forests, interspersed with large tracts under rubber, eucalyptus and teak plantations and a sprinkling of hamlets whose mostly tribal population is not yet weaned away from its traditional slash-and-burn method of cultivation. Poaching and large-scale illegal tree felling are rampant.

The western end of Chorao (Tiswadi), an alluvial island in the inland estuary of the Mandovi river, was only recently notified as the Dr. Sálim Ali Bird Sanctuary. Its 1.8 sq. km consist of the last sizeable mangrove forest in Goa's coastal belt, and is therefore worth protecting, but it contains no avian life worth mentioning.

On the other hand there is Carambolim lake, a freshwater village tank of 0.7 sq. km, situated close to the World Heritage site of Old Goa. Throughout the year, it sustains a large and varied population of resident waterfowl and in winter an immense number of migratory ducks, well over 35,000 in normal years and over 75,000 in the winter of 1987-88, when large parts of India were affected by drought, while Goa had the benefit of an adequate monsoon. The Carambolim lake has been shown by way of the Asian mid-winter waterfowl count (Daniel 1988) to be the major wintering quarter of migratory ducks in peninsular India, and one of the most important in the Subcontinent. Under the Ramsar Convention, which India signed in 1982, this village tank would qualify for inclusion in the list of about 300 protected wetlands of international importance the world over. Yet, the Goa government deems it unfit even to be declared a bird sanctuary!

The most effective means of protection appears to be private ownership. At Corlim (Tiswadi), close to the Carambolim lake, the Swiss-owned Hindustan Ciba-Geigy Ltd. produces at its Santa Monica plant a range of highly toxic pesticides for agricultural use. The large factory compound contains two shallow ponds that give undisturbed shelter to Goa's only known heronry, and a safe haven to quite a number of migrant and vagrant Ciconiidae and Threskiornithidae. Despite the tight security around the plant, ornithologists are encouraged by the General Manager, himself an amateur birdwatcher, to visit the site.

A Note on the Systematic List

— All observations and records, if not mentioned otherwise, are by the author.
— The number in brackets after the serial number of each species refers to the "Synopsis number" of Ali and Ripley (1995).
— I have followed the sequence used in the SYNOPSIS (Ripley 1982) by inserting the species numbered 429-44 between nos. 361 and 362.
— To facilitate locating places on a detailed map, the name of the taluka (an administrative unit) is added in brackets.
— Quantitative terms used in the text:

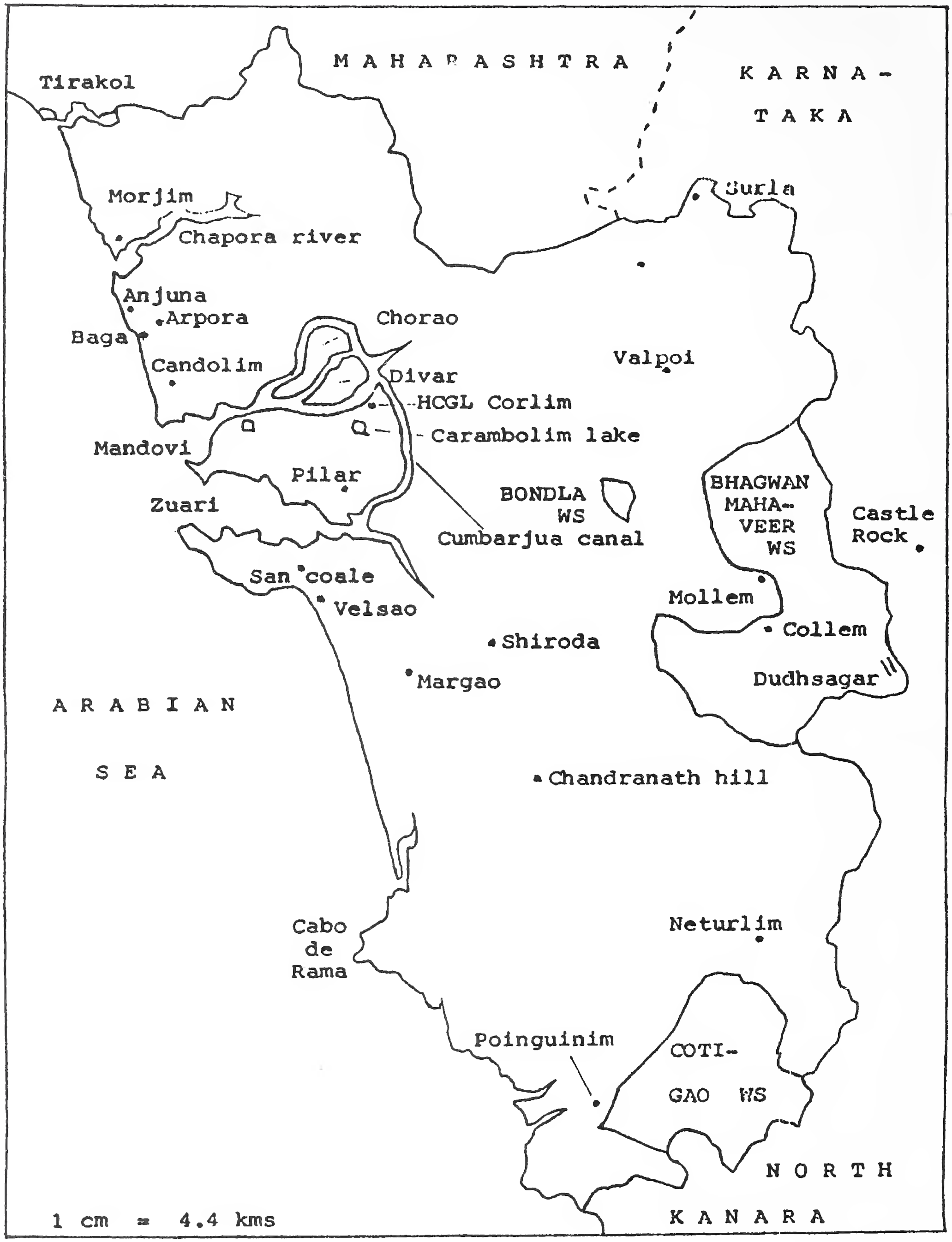

Fig. 1: Map of Goa (with Wildlife Sanctuaries and other places of ornithological interest)

Small	numbers	= < 50
Moderate	"	= 50-200
Considerable	"	= 200-1000
Large	"	= 1000-10000
Very large	"	= > 10000

Abbreviations:

WS: Wildlife Sanctuary

BMWS: Bhagwan Mahaveer Wildlife Sanctuary

HCGL: Hindustan Ciba- Geigy Ltd. at Corlim (Tiswadi)

SYSTEMATIC LIST OF BIRDS

(Unconfirmed records of birds that are difficult to identify in the field and records within 5 km beyond Goa's borders are appended.)

1. (5) **Little Grebe *Tachybaptus ruficollis* (Pallas)**

Resident in moderate numbers. Thinly spread over the freshwater bodies of the coastal belt, though one specimen was observed in the totally saline estuary of the Tirakol river. Small numbers breed from July to February.

2. (14) **Wilson's Storm Petrel *Oceanites oceanicus* (Kuhl)**

Passage migrant in probably large numbers. Migration along Goa's coast starts in mid-August and peaks in the first week of September, when a sweep with a field-scope rarely shows less than 20 birds foraging and moving southward at a sedate pace (*ca*. 200-300 m offshore). The last stragglers are seen in early October.

3. (23) **Masked Booby *Sula dactylatra* Lesson**

Vagrant. Davidson (1898) 'obtained a specimen of this bird at Sadasheogarh on June 23, 1893. It was blown ashore and captured alive.' Sadasheogarh, now renamed Sadashivgad, is North Kanara's northernmost coastal village, and borders on Goa.

On August 4, 1997, I observed a masked booby *ca*. 300 m. offshore at Anjuna (Bardez).

4. (25) **Brown Booby *S. leucogaster* (Boddaert)**

Vagrant. In early June 1997, I observed an adult bird coming in and settling just beyond the surf-line off Anjuna Beach, possibly a storm-blown specimen, as the previous day a cyclonic depression had crossed over from the northern Arabian Sea into Saurashtra. This appears to be only the second record from India's West Coast (HANDBOOK 1:34 35).

5. (26) **Cormorant *Phalacrocorax carbo* (Linn.)**

Rare visitor. Ones and twos were observed in the HCGL compound at Corlim (Tiswadi) during June, September, December and January.

6. (27) **Indian Shag *P. fuscicollis* Stephens**

Breeding visitor. Moderate numbers (up to 100 pairs) breed annually in the heronry inside the HCGL compound from mid-July to end of January.

7. (28) **Little Cormorant *P. niger* (Vieillot)**

An increasingly common and considerably numerous resident. In the dry season, the population is evenly spread out over wetlands of the coastal region (occasionally up to the base of the Western Ghats). With the onset of the SW monsoon, these birds congregate at a pond inside the HCGL compound, where about 200 pairs breed between late June and early December.

8. (29) **Darter *Anhinga rufa* (Daudin)**

Apparently a regular breeding visitor. Up to 10 birds arrive by end May at the HCGL heronry and breed there from end June to early November. Usually by mid-December all birds have left.

9. (36) **Grey Heron *Ardea cinerea* Linn.**

Moderately common non-breeding resident, found throughout the coastal belt. During the SW monsoon, the few birds that have not evaded the rains gather at the fringes of the heronry at Corlim (Tiswadi).

10. (37) **Purple Heron *A. purpurea* Linn.**

Rather uncommon and moderately numerous resident of the coastal belt and river basins as far as tidal influence reaches. Up to 35 pairs breed regularly in the HCGL heronry

between mid-May and early October.

11. (38) **Little Green Heron *Ardeola striatus* (Linn.)**

Common and considerably numerous resident of the coastal strip, from offshore islands and rocky sea-shore ascending the tidal rivers and creeks up to 15 km inland. Also found at saltpans and rock-strewn freshwater streams. Fledglings were seen in May.

12. (42) **Pond Heron *A. grayii* (Sykes)**

Resident and local migrant. One of the most common and numerous birds of Goa, less so during monsoon. Found from offshore islands to streams in dense evergreen forest along the Western Ghats strip. Uncommon breeder during the SW monsoon.

13. (44) **Cattle Egret *Bubulcus ibis* (Linn.)**

A common and numerous dry season visitor ranging from the coastal belt to the foot of the Ghats. Up to 2,000 birds may congregate at the Carambolim tank in April before moving out in the first week of June to evade the rains. They return towards mid-September when the worst of the monsoon is over.

14. (46) **Large Egret *Ardea alba* Linn.**

Fairly uncommon resident in moderate numbers. Confined to the coastal belt where up to 50 individuals may be encountered in a single marsh. About the same numbers breed between late April and mid-September at the heronry in the HCGL compound.

15. (47) **Smaller Egret *Egretta intermedia* (Wagler)**

A common and moderately numerous local migrant. Restricted to the coastal belt and river basins. Most birds absent themselves during the SW monsoon, from mid-June to mid-September, presumably moving up into the Deccan.

16. (49) **Little Egret *E. garzetta* (Linn.)**

Common and very numerous dry season visitor, from just behind the sea-shore to the base of the Western Ghats. These egrets leave by mid-June and return towards mid-September with only a few individuals staying on during the rains.

17. (50) **Indian Reef Heron *E. gularis* (Bosc)**

A dry season visitor, commonly occurs in moderate numbers, along the sea-shore and inland estuaries of the larger rivers, where over a hundred may congregate on tidal mudflats. The reef heron's pre-monsoon withdrawal lasts from mid-April till the first week of June when all the birds have disappeared, only to return from mid-September onwards. Although Dharmakumarsinhji and Lavkumar (1956) reported an enigmatic 'heronry of reef herons right in the centre of the Oyster Rock off Karwar' just a dozen km south of Goa, there is no indication of their breeding anywhere in Goa.

18. (52) **Night Heron *Nycticorax nycticorax* (Linn.)**

Uncommon winter visitor in small numbers. There are just a dozen or so records, ranging from the end of October to mid-March, all from the coastal belt and river basins. Hume (1876) mentioned to have seen a 'colony' of night herons on St. George's Island off Bogmalo Beach (Marmagoa) but does not say if they were breeding. However, there was certainly no breeding colony in Goa for the last 17 years.

19. (53) **Malay Bittern *Gorsachius melanolophus* (Raffles)**

I observed a single Malay bittern in semi-evergreen forest at the foot of the Anmod Ghat, in the BMWS, in July 1985, at the height of the SW monsoon. Davidson (1898) reported to 'have seen the bird at ...Anshi..., all in May, and at many places round Karwar in the rains'. Both locations are only a dozen km to the south of Goa.

20. (56) **Chestnut Bittern *Ixobrychus cinnamomeus* (Gmelin)**

A fairly common and moderately numerous monsoon visitor that is found in paddy fields, at ponds and mangrove-lined creeks, from just behind the sea-shore to the base of the Ghats. This bittern makes its appearance towards the end of June and winds up its season by mid-October, unseasonal records being few.

21. (57) **Yellow Bittern *I. sinensis* (Gmelin)**

Status unclear. There were a number of sightings of two adults and an immature bird at a patch of sea-holly in a saline marsh along the Baga (Bardez) creek, between December 1995 and May 1996.

22. (60) **Painted Stork *Mycteria leucocephala* (Pennant)**

Stray. Throughout March 1997, up to 4 birds were seen in marshes at Shiroda (Ponda) and at their night-roost in the HCGL compound at Corlim (Tiswadi).

23. (61) **Openbill Stork *Anastomus oscitans* (Boddaert)**

An uncommon and rather irregular dry season visitor to the coastal belt and river basins; up to 60 birds were counted in a single marsh. In recent years, appearances and even oversummering seem to be more frequent.

24. (62) **White-necked Stork *Ciconia episcopus* (Boddaert)**

Uncommon, but regular dry season visitor in moderate numbers. Met with at creeks and marshes of the coastal region, where up to 55 individuals may congregate. Occasionally seen soaring along or above the crest of the Sahyadris. Their habitual night-roost is at the HCGL compound. Not yet recorded between early June and mid-October.

25. (63) **White Stork *C. ciconia* (Linn.)**

Vagrant. A single adult was observed soaring above the Dudhsagar waterfalls, in the BMWS, and resting in the HCGL compound at Corlim (Tiswadi), in February 1998.

26. (65) **Black Stork *C. nigra* (Linn.)**

Vagrant. An adult and an immature specimen were recorded in January 1998 at the ponds in the HCGL compound.

27. (68) **Lesser Adjutant *Leptoptilos javanicus* (Horsfield)**

Small numbers (up to 18 in a group) of this rather scarce visitor are found regularly at wetlands situated between the Zuari and Mandovi rivers, the focal point being the HCGL heronry. One bird was seen circling low over secondary forest at the base of the Western Ghats. Not yet recorded during June-July.

28. (69) **White Ibis *Threskiornis aethiopica* (Latham)**

Rather rare visitor in very small numbers. Liable to turn up at any season, on freshwater bodies throughout the coastal belt and river basins.

29. (71) **Glossy Ibis *Plegadis falcinellus* (Linn.)**

Scarce winter visitor in moderate numbers. Since 1988, this species appears irregularly in singles and groups of up to 72 individuals at riverine freshwater marshes of the coastal region.

30. (72) **Spoonbill *Platalea leucorodia* (Linn.)**

Straggler. There are 8 records of up to 19 birds from the Carambolim lake and the ponds in the HCGL compound, all during March, May and June.

31. (88) **Lesser Whistling Teal *Dendrocygna javanica* (Horsfield)**

A resident in small numbers, and a dry season visitor in considerable numbers. Found at wetlands of the coastal belt and river basins, and occasionally seen travelling over the open sea along the coastline. Gatherings of up to 800 birds are not uncommon at the Carambolim lake; the highest number, 1300+ ducks, was recorded at the HCGL ponds in March. These birds are absent from the end of April till late August, though a dozen or so hang on throughout the monsoon, now and then. Breeding is rare, seen in August-September.

32. (90) **Ruddy Shelduck *Tadorna ferruginea* (Pallas)**

I have had only three sightings of up to 20 birds, from different wetlands in the river basins, in November-December.

33. (93) **Pintail *Anas acuta* Linn.**

A regular winter visitor in very large numbers, occurs sporadically in wetlands of the river basins, mainly at the Carambolim lake and on mudflats in the nearby inland-estuary of Mandovi, with maximum numbers (Jan.-Feb.)

averaging close to 35,000 over a period of 6 years. More than 70,000 birds were estimated to be present for a couple of weeks in January 1988, the largest single number recorded in the area covered by the annual Asian Mid-winter Waterfowl Count for this year (Daniel 1988). Apparently, the drought conditions prevailing in northern India had forced the birds further south into the peninsula, where wetlands were filled by a more than sufficient monsoon.

The majority of pintails arrive in the first week of October and leave by late March, with one or two drakes lingering on right into the rains.

34. (94) **Common Teal *A. crecca* Linn.**

Uncommon winter visitor in small numbers. Found at wetlands of the coastal region from the end of October till early April, in flocks ranging up to 200 (at the Carambolim lake).

35. (97) **Spotbill Duck *A. poecilorhyncha* J.R. Forster**

A very rare winter visitor to the Carambolim lake and the nearby inland-estuary of Mandovi, in January and March. There are only 5 records from 4 years. The maximum number, 12 birds, was seen by Willoughby (1996) in March.

36. (100) **Mallard *A. platyrhynchos* Linn.**

Very rare winter visitor to the Carambolim lake and mudflats in the Mandovi river. I have 4 records in 3 years of up to 15 birds from Nov. to Feb.

37. (101) **Gadwall *A. strepera* Linn.**

A rare winter visitor to the inland estuary of the Mandovi and Carambolim lake. There were 6 sightings of up to 7 birds, between October and March.

38. (103) **Wigeon *A. penelope* Linn.**

Very rare winter visitor to the Carambolim lake and mudflats in the Mandovi. The existing 5 records are of single birds, between October and March.

39. (104) **Garganey *A. querquedula* Linn.**

A dry season visitor in large numbers. It might turn up at any saline, brackish or freshwater wetland throughout the coastal region, and occasionally even over the open sea. Well over 4,000 birds winter regularly at the Carambolim lake (maximum 8,000+ in January 1991). These ducks start arriving by the end of September and depart towards the end of April, with a few staying on right into July.

40. (105) **Shoveller *A. clypeata* Linn.**

A regular winter visitor to freshwater bodies of the coastal belt and to estuaries. A maximum number of 11 birds was recorded at the Carambolim lake. Present from late September till early May.

41. (108) **Common Pochard *Aythya ferina* (Linn.)**

Very rare winter visitor. I have three records of up to 6 birds from Carambolim lake and the tidal mudflats of the Mandovi river, in October, November and January.

42. (109) **Ferruginous Duck *A. nyroca* (Güldenstädt)**

A scarce winter visitor, the 7 existing records are of a single bird in the fully saline mouth of the Chapora river, in November, and of up to three birds at the Carambolim lake, in December-January.

43. (111) **Tufted Duck *A. fuligula* (Linn.)**

Vagrant. I saw two drakes on the tidal mudflats in the inland estuary of the Mandovi river, in November 1987.

44. (114) **Cotton Teal *Nettapus coromandelianus* (Gmelin)**

Common, dry season visitor to wetlands throughout the coastal and midland regions. The largest gatherings, often more than 400, occasionally up to 800 birds, are found at the Carambolim lake. Generally absent from early May till mid-November, though a few regularly stay on during the rains.

45. (115) **Comb Duck *Sarkidiornis melanotos* (Pennant)**

A regular winter visitor from mid-November to early April, with one or two birds lingering on till the end of May. Found only at the Carambolim lake and the ponds in the HCGL

compound at Corlim (Tiswadi), where up to 80 birds may congregate.

46. (124) **Black-winged Kite *Elanus caeruleus* (Desfontaines)**

Uncommon dry season visitor in small numbers. Occurs from the coastal plain to the foot of the Western Ghats, between the end of October and early June.

47. (127) **Black-crested Baza *Aviceda leuphotes* (Dumont)**

Status unclear. I have two records (March 1987 and 1989) from the same ridge in dense, wet, evergreen forest, in the BMWS, at an altitude of *ca*. 500 m.

48. (130) **Honey Buzzard *Pernis ptilorhyncus* (Temminck)**

A fairly common dry season breeding visitor that takes evasive action during the monsoon, absenting itself from the end of May till mid-October. Moderate but slowly declining numbers (rapidly in the coastal belt) of this raptor are almost evenly spread out over the whole state. Breeding was recorded throughout the dry season.

49. (133) **Pariah Kite *Milvus migrans* (Boddaert)**

A very common (almost) resident in considerable numbers. Found throughout the coastal belt and, to a lesser degree, in the midland region. This raptor is the most typical monsoon fugitive and the most accurate indicator of the imminent rains. It leaves a week ahead of the advancing monsoon in a steady stream, at times over 50 birds within 10 minutes, moving northwards along the coast. The return movement in early September is less dramatic.

50. (135) **Brahminy Kite *Haliastur indus* (Boddaert)**

A very common resident of the coastal region, where congregations of up to 300 birds may occur at suitable wetlands. It moves up along the larger rivers as far as tidal influence reaches. Numbers decline sharply during monsoon. Breeding was recorded in April and August.

51. (139) **Shikra *Accipiter badius* (Gmelin)**

A fairly common, moderately numerous resident from the seashore to the base of the Western Ghats. Breeding in April and July. Numbers are declining steadily since the mid-eighties.

52. (144) **Crested Goshawk *A. trivirgatus* (Temminck)**

Rare resident(?). Grubh and Ali (1975) sighted this raptor in the BMWS during Nov.-Dec. 1972. Saha and Dasgupta collected a specimen in the Bondla WS in October 1977. I have recorded a single bird in the Cotigao WS in October 1987, and a pair each in May 1996 and 1997, both in display flight near the Dudhsagar waterfalls in the BMWS.

53. (147) **Sparrow-Hawk *A. nisus* (Linn.)**

A rare winter visitor. There are 5 records of single birds from the BMWS, in October, January and February.

54. (151) **Besra Sparrow-Hawk *A. virgatus* (Temminck)**

First noted by Rane (1982) sometime between April and June 1982, in the BMWS. I saw three birds at different localities of the same WS on a single day in February 1987 and a single bird in December 1995.

55. (153) **Long-legged Buzzard *Buteo rufinus* (Cretzschmar)**

Stray. Throughout January and February 1997, one bird frequented pasture land at the coastal village of Candolim (Bardez).

56. (157) **White-eyed Buzzard-Eagle *Butastur teesa* (Franklin)**

Saha and Dasgupta (1992) reportedly saw this raptor near Margao (Salcete) and Valpoi (Sattari) in December 1968 and January 1969, respectively. Specimens were collected by Grubh and Ali (1975) in the BMWS and others were noted at Mayem (Bicholim) and Canacona, in Nov.-Dec. 1972.

I have identified this bird with certainty only once, on Chorao Island (Tiswadi), in February 1985.

57. (161) **Crested Hawk-Eagle *Spizaetus cirrhatus* (Gmelin)**

An uncommon resident, in small numbers, of the Western Ghats section and patches of remnant evergreen and semi-evergreen forest on the scarp of plateaus facing the coastal strip. Breeding was noted in February, March and August.

58. (163) **Bonelli's Eagle *Hieraaetus fasciatus* (Vieillot)**

Straggler. I have three sightings of single birds from the coastal lowlands, during the months of January-March.

59. (164) **Booted Hawk-Eagle *H. pennatus* (Gmelin)**

A common winter visitor in small numbers. Found between early October and mid-April, mainly in the coastal belt, rarely at the base of the Ghats.

60. (165) **Rufous-bellied Hawk-Eagle *H. kienerii* (E. Geoffroy)**

Very rare resident. Single birds were recorded in all seasons at the top of the Dudhsagar waterfalls, in the BMWS.

61. (170) **Greater Spotted Eagle *Aquila clanga* Pallas**

Scarce winter visitor in very small numbers to larger wetlands in the coastal region, from end October to late March.

62. (172) **Black Eagle *Ictinaetus malayensis* (Temminck)**

Uncommon, but regular dry season visitor, in small numbers, from the first week of November to mid-May. Found mainly in the Western Ghats and their outlying hills, rarely in the coastal belt.

63. (173) **White-bellied Sea-Eagle *Haliaeetus leucogaster* (Gmelin)**

A fairly common resident along the sea-coast. The breeding population along Goa's 133 km long coastline consists of at least 16 pairs; breeding season appears to be September to January.

These beautiful eagles are still a fairly common sight at the state capital Panaji, where they used to breed occasionally at Malim (Bardez), just across the Mandovi river. Some venture up to 15 km inland along the larger tidal rivers and even ascend non-tidal rivers into dense semi-evergreen forest (Cotigao WS).

64. (175) **Grey-headed Fishing Eagle *Ichthyphaga ichthyaetus* (Horsfield)**

Vagrant. A single sub-adult was observed at a freshwater reservoir on top of a barren lateritic plateau near Sancoale (Marmagoa), in November 1987.

65. (185) **Indian White-backed Vulture *Gyps bengalensis* (Gmelin)**

A not frequently seen resident. The not very local population of approx. 45 birds may turn up anywhere, from a seaside village to the crest of the Western Ghats. A sharp decline in numbers has been noticed since 1995.

66. (186) **Egyptian Vulture *Neophron percnopterus* (Linn.)**

Stray. A single was observed soaring above the Dudhsagar waterfalls in the BMWS, in January 1997.

67. (190) **Pale Harrier *Circus macrourus* (S.G. Gmelin)**

Rather scarce, irregular winter visitor (in ones and twos). Recorded in the coastal plains and on isolated coastal plateaus from mid-October to early March.

68. (191) **Montagu's Harrier *C. pygargus* (Linn.)**

Rare and irregular winter visitor. There are only 5 records (of singles and a pair) in eleven years, all from the coastal lowlands, between December and February.

69. (192) **Pied Harrier *C. melanoleucos* (Pennant)**

Vagrant. I had a sighting of the strikingly patterned male on Divar (Tiswadi) island, in the inland-estuary of the Mandovi, in December 1989.

70. (193) **Marsh Harrier *C. aeruginosus* (Linn.)**

A regular and fairly common winter visitor in small numbers. Confined to the coastal belt

and the river basins, it arrives usually by mid-September and leaves around mid-April.

71. (195) **Short-toed Eagle *Circaetus gallicus* (Gmelin)**

Rare and irregular winter visitor, in singles and pairs, to the coastal belt, between December and March.

72. (196) **Crested Serpent Eagle *Spilornis cheela* (Latham)**

A common and moderately numerous resident in all three zones, from pockets of remnant semi-evergreen forest on coastal headlands to the crest of the Sahyadris.

73. (203) **Osprey *Pandion haliaetus* (Linn.)**

Uncommon but regular winter visitor to the coastal strip and up to 15 km inland in the river basins. Small numbers are present from mid-September till the first week of April. Sub-adult birds occasionally brave the rains and stay on during the SW monsoon.

74. (209) **Peregrine Falcon *Falco peregrinus* Tunstall**

Small numbers of this uncommon winter visitor are found throughout the coastal strip, from mid-October to the end of March. Grubh and Ali (1975) had noted the nominate race at the BMWS, in November-December 1972.

75. (222) **Kestrel *F. tinnunculus* (Linn.)**

An uncommon but regular winter visitor. Small numbers occur between early October and late March at coastal plateaus and lowlands, exceptionally also at the foot of the Ghats.

76. (250) **Grey Quail *Coturnix coturnix* (Linn.)**

A scarce winter visitor in very small numbers, recorded during Jan.-Feb. in the coastal belt and at the base of the Sahyadris. Noted by Grubh and Ali (1975) at Valpoi (Sattari), in November-December.

77. (252) **Black-breasted Quail *C. coromandelica* (Gmelin)**

Monsoon visitor in small numbers, found on pasture land and neglected rice paddies on the alluvial islands in the inland-estuary of the Mandovi and on grassy lateritic plateaus bordering the coastal belt, from end-June to mid-November.

78. (255) **Jungle Bush Quail *Perdicula asiatica* (Latham)**

An uncommon and moderately numerous resident of lateritic plateaus, even coastal ones. There are indications of their breeding in June-July.

79. (275) **Red Spurfowl *Galloperdix spadicea* (Gmelin)**

Fairly common resident, in considerable numbers, of plateaus (coastal and midland) up to the foot of the Ghats. Breeding was recorded in August-September.

80. (301) **Grey Junglefowl *Gallus sonneratii* Temminck**

A fairly common, considerably numerous resident of the Western Ghats strip and its outlying hills. An unusually large population seems to reside outside (!) the boundaries of the Bondla WS.

81. (311) **Common Peafowl *Pavo cristatus* Linn.**

Fairly common resident, in considerable numbers, of the plateau region. The population appears to be increasing steadily, even advancing to the coast by way of several headlands. Breeding noted in August.

82. (318) **Common Bustard-Quail *Turnix suscitator* (Gmelin)**

A rather scarce resident in unknown numbers. I have come across this bird in 4 localities on the scarp of plateaus and at the base of the Western Ghats. Grubh and Ali (1975) had noted it in 'various localities' in 1972.

83. (229) **Blue-breasted Banded Rail *Rallus striatus* Linn.**

Uncommon resident of mangrove-fringed tidal creeks. Davidson (1898) had found this rail 'common about Karwar (14 km to the south of Goa) in the rains…'

84. (337) **Baillon's Crake *Porzana pusilla* (Pallas)**

Straggler(?) I caught a specimen of this crake that was traipsing through a coconut-palm

grove just behind the beach, at Anjuna (Bardez), in March 1981. In November 1988, I saw a Baillon's Crake at a little freshwater pond beside the Baga (Bardez) creek.

85. (339) **Ruddy Crake *P. fusca* (Linn.)**

I have a single record of one bird at the Baga (Bardez) creek, in October 1987, where Willoughby (1996) saw it in November 1995.

86. (343) **White-breasted Waterhen *Amaurornis phoenicurus* (Pennant)**

A common and numerous resident of the coastal and midland regions. Breeding was noted from June to October.

87. (346) **Watercock *Gallicrex cinerea* (Gmelin)**

Stray (?). There are only two sightings: two birds at the Carambolim lake, in June 1996, and one at the fringes of the Nerul (Bardez) marsh, in November 1996 (G. Frost, N. Manville, pers. comm.)

88. (347) **Moorhen *Gallinula chloropus* (Linn.)**

A common and moderately numerous winter visitor to freshwater bodies in the coastal belt and river basins, from late September till early April. Numerous fledglings that were barely able to fly were observed in late October.

89. (349) **Purple Moorhen *Porphyrio porphyrio* (Linn.)**

A considerably numerous resident with strong seasonal fluctuations at the Carambolim lake, and off and on, a nearby pond at Pilar (Tiswadi). Up to 500 individuals congregate during December and January; numbers dwindle during the hot season to single digits. A few pairs breed irregularly in April, September and January.

90. (350) **Coot *Fulica atra* Linn.**

A common winter visitor to the larger tanks and ponds of the coastal region, from mid-October to the first week of May, with singles occasionally remaining into early June. Assemblies of over 2,000 birds are to be found at the Carambolim lake during December-January.

91. (358) **Pheasant-tailed Jacana *Hydrophasianus chirurgus* (Scopoli)**

A fairly common resident of freshwater wetlands throughout the coastal belt and river basins. Maximum numbers, up to 600 birds, may be seen in January at the Carambolim lake. This jacana shuns the rains and the greater part of the population evades the monsoon from end May to early August. Breeding was noted from September-December.

92. (359) **Bronze-winged Jacana *Metopidius indicus* (Latham)**

A fairly common resident of freshwater ponds and tanks in the river basins. Over the last 8 years the population has increased rapidly, with over 200 birds, in May 1996, at the Carambolim lake alone. Only small numbers stay on during the three months of heavy monsoon rains and equally small numbers breed between August and October.

93. (360) **Oystercatcher *Haematopus ostralegus* Linn.**

Irregular and uncommon winter visitor to the coast, from mid-September to late March; an occasional single may show up during the SW monsoon. The largest group on record consisted of 19 birds. Not recorded since 1989.

94. (429) **Painted Snipe *Rostratula benghalensis* (Linn.)**

Status uncertain. Sightings, at brackish and freshwater marshes of the coastal region, started in 1988 and are becoming more frequent in recent years. This bird is probably a year-round resident, except for the driest part of the dry season. A maximum of 8 specimens were seen in a single locality.

95. (430) **Black-winged Stilt *Himantopus himantopus* (Linn.)**

An uncommon but regular visitor from October-April, occasionally to mid-June, to the coastal belt and river basins; sometimes ventures up to irrigated paddy fields at the foot of the Ghats. A maximum of 47 birds were counted at the Carambolim lake.

96. (434) **Crab Plover *Dromas ardeola* Paykull**

Stray. A single adult specimen was observed on tidal mudflats in the estuary of the Chapora river, in October 1996.

97. (436) **Stone Curlew *Burhinus oedicnemus* (Linn.)**

Stray. I saw one bird on a sparsely wooded grassy lateritic plateau at the coastal village of Arpora (Bardez), in September 1981.

98. (443) **Collared Pratincole *Glareola pratincola* (Linn.)**

Straggler. I have 4 records of up to 14 birds: three from freshwater wetlands in the coastal belt and one from a saline estuary, between late September and the beginning of March.

99. (444) **Small Indian Pratincole *G. lactea* Temminck**

A fairly common but capricious winter visitor, in large numbers, to the coastal belt and river basins, from early November to late April. Several flocks of over 2,000 birds were recorded, often along the high water line of beaches.

100. (365) **Grey-headed Lapwing *Vanellus cinereus* (Blyth)**

Vagrant. A sub-adult bird was sighted at an almost dry tidal marsh beside the Baga (Bardez) creek on three consecutive days in January 1989 (Lainer 1989).

101. (366) **Red-wattled Lapwing *V. indicus* (Boddaert)**

Common, considerably numerous resident, found from the seashore to the foot of the Ghats. Breeds from April to July.

102. (370) **Yellow-wattled Lapwing *V. malabaricus* (Boddaert)**

Rather uncommon, dry season visitor in moderate numbers. Occurs from wasteland behind the beaches to the base of the Western Ghats. It appears to be declining since the early eighties.

103. (371) **Grey Plover *Pluvialis squatarola* (Linn.)**

Uncommon, somewhat irregular winter visitor in moderate numbers to beaches and estuaries, sometimes also on plateaus near water. There is a pronounced autumn migration between mid-August and late September.

104. (373) **Eastern Golden Plover *P. dominica* (P.L.S. Muller)**

A common, regular winter visitor in moderate numbers, from mid-September to early May. Frequents rocky sea-coast, saline and brackish marshes. Over 180 birds were counted in a single flock.

105. (374) **Large Sand Plover *Charadrius leschenaultii* Lesson**

A common, moderately numerous dry season visitor to beaches and tidal mudflats in estuaries, from late August to end May.

106.(378) **Ringed Plover *C. hiaticula* Linn.**

A single adult specimen was found among 15 little ringed plovers on the pebbly shore of the freshwater reservoir on the Sancoale (Marmagoa) plateau, in Nov. 1987.

107. (380) **Little Ringed Plover *C. dubius* Scopoli**

Common and considerably numerous winter visitor, spreading from the coastal strip to the base of the Ghats. This plover arrives in early October and moves out by mid-April, though a few may linger on a month longer.

108. (381) **Kentish Plover *C. alexandrinus* Linn.**

An uncommon, irregular winter visitor to beaches and tidal mudflats. Numbers vary capriciously from a single or a dozen in one year to several hundreds the next. Recorded from early September to mid-March.

109. (384) **Lesser Sand Plover *C. mongolius* Pallas**

A common winter visitor in large though highly fluctuating numbers to the entire seaboard and the estuaries, from mid-Sept. to mid-April. Occasionally singles or small groups stay on during the SW monsoon. Flocks of over 2,000 birds are no rarity during Dec.-Jan.

110. (385) **Whimbrel *Numenius phaeopus* (Linn.)**

A common winter visitor in small numbers to the coast and estuaries, this wader is the

earliest to arrive (usually mid-July) and the first to depart (early March).

111. (388) **Curlew *N. arquata* (Linn.)**

Fairly common winter visitor, in small numbers, to beaches and tidal mudflats in estuaries, from late August to the first week of May.

112. (389) **Black-tailed Godwit *Limosa limosa* (Linn.)**

Sporadic autumn passage migrant. I have 7 records of singletons and a threesome, ranging from late Aug. to mid-Dec., from flooded paddies, saltpans and tidal mudflats in estuaries.

113. (391) **Bar-tailed Godwit *L. lapponica* (Linn.)**

Scarce but apparently regular winter visitor to beaches and tidal mudflats. The two or three annual sightings (of up to 12 birds in a group) fall between the first week of September and early March.

114. (392) **Spotted Redshank *Tringa erythropus* (Pallas)**

Straggler. There are less than 10 records, all from the coastal belt, from November to late April, 1995-97.

115. (393) **Common Redshank *T. totanus* (Linn.)**

A common visitor, in large numbers, to wetlands in the coastal strip and river basins. The first trickle of migrants arrives by the end of July, the majority following in late Sept. Outward migration begins in April, with a few birds staying on till early June.

116. (395) **Marsh Sandpiper *T. stagnatilis* (Bechstein)**

Uncommon, but regular winter visitor in very small numbers to the coastal belt, where it seems to favour saltpans. Present in twos and threes from late August to early April.

117. (396) **Greenshank *T. nebularia* (Gunner)**

Common visitor in considerable numbers to various water bodies, from the coastal strip to the base of the Ghats. Arrival and departure times are ill-defined, since some non-breeding birds tend to stay on in the monsoon.

118. (397) **Green Sandpiper *T. ochropus* Linn.**

Common winter visitor in small numbers. Found in all three zones, but mainly in the coastal belt. Arrives about the beginning of September and departs by mid-April. Rarely stays on till the monsoon.

119. (398) **Wood Sandpiper *T. glareola* Linn.**

A common winter visitor, in large numbers, to wetlands from just behind the seashore to the base of the Sahyadris. The first birds usually arrive in mid-Sept.; outward migration is over by mid-May. Numbers in a single wetland can be up to 3,000 in some years.

120. (400) **Terek Sandpiper *T. terek* (Latham)**

A fairly common winter visitor, in small numbers, to beaches, estuaries and saline marshes throughout the coastal belt. Absent only from early June to late August Flock size ranges up to 40.

121. (401) **Common Sandpiper *T. hypoleucos* Linn.**

Ubiquitous dry season visitor to freshwater and saline wetlands of the three zones. Avoids the heaviest rains by moving out around mid-May and returning in early August.

122. (402) **Turnstone *Arenaria interpres* (Linn.)**

Uncommon and erratic autumn passage migrant; found on tidal mudflats in estuaries from late August to mid-October. The occurrence of a single specimen in mid-Jan. seems to be exceptional. Flock size does not exceed a dozen.

123. (406) **Pintail Snipe *Gallinago stenura* (Bonaparte)**

A common, regular winter visitor in smallish numbers. Mostly met with at the fringe of saline marshes in the coastal belt. Present from end September to mid-April.

124. (409) **Fantail Snipe *G. gallinago* (Linn.)**

A common, slightly irregular and moderately numerous winter visitor to flooded paddy

fields in all three zones and to saline marshes, from early October to late April. Up to 300 birds assemble at times in irrigated paddies that are under the plough for the winter crop.

125. (413) **Eastern Knot *Calidris tenuirostris* (Horsfield)**

Rare winter visitor or passage migrant. I have 6 sightings of up to 14 birds, on beaches and in estuaries, from October to November and March.

126. (414) **Sanderling *C. alba* (Pallas)**

An uncommon but regular winter visitor, in moderate numbers, to sandy beaches and estuarine mudflats. Arrives by mid-August and departs by March-end. Flock size usually up to 30, rarely exceeding 100 individuals.

127. (416) **Little Stint *C. minuta* (Leisler)**

Common, moderately numerous winter visitor to wetlands throughout the coastal belt, estuarine mudflats and, rarely, beaches. Begins to arrive in the first week of September and the last birds depart in early May. Flocks rarely more than a hundred birds.

128. (417) **Temminck's Stint *C. temminckii* (Leisler)**

A fairly common winter visitor in moderate numbers (up to a hundred birds in a single flock) to freshly ploughed, soggy paddy fields and less frequently, to saline wetlands of the coastal region. This little wader is one of the last to arrive in its winter quarters (first week of November; departure is over by late April).

129. (420) **Dunlin *C. alpina* (Linn.)**

An uncommon, slightly irregular winter visitor in small numbers. Frequents beaches, estuarine mudflats from early September to first week of March. Assemblies of up to 30 may be seen.

130. (422) **Curlew Sandpiper *C. testacea* (Pallas)**

Scarce visitor, in ones and twos, to saline marshes and saltpans. There are 8 sightings from end-July to the first week of May.

131. (424) **Broad-billed Sandpiper *Limicola falcinellus* (Pontoppidan)**

Rare passage migrant. Up to 19 birds were recorded during September on Divar (Tiswadi) island, in the inland estuary of the Mandovi.

132. (426) **Ruff *Philomachus pugnax* (Linn.)**

Scarce winter visitor to soggy rice paddies and, rarely, saline wetlands in the coastal region. Recorded from mid-September to early February in numbers ranging up to 35 birds.

133. (448) **Parasitic Skua *Stercorarius parasiticus* (Linn.)**

Straggler(?) I have 5 records of ones and twos off the coast of Anjuna (Bardez), in September. I am sure they are much more frequent visitors to Goa's coast than these few records suggest. Madsen (1988) had observed them frequently off the coast at Gokarn (North Kanara), *ca.* 140 km south of Anjuna, between September 1987 and January 1988. When Madsen and I visited the Vengurla Rocks off Malwan (Sindhudurg dist., Maharashtra), only 45 km north of Anjuna, in March 1989, we saw several parasitic skuas every day.

134. (450) **Herring Gull *Larus argentatus* (Pontoppidan)**

A common, moderately numerous winter visitor to the entire coastline. For years I hesitated to ascribe any of the baffling large white-headed gulls, even when they were in well-defined adult plumage, to this or the following species. However, a number of visiting British bird-watchers, who were familiar with both species, identified the majority as *L. argentatus heuglini*. The largest concentrations, of well over 500 birds, occur on Morjim (Pernem) beach. They arrive in early October, and depart towards end April.

135. (452) **Lesser Black-backed Gull *L. fuscus* Linn.**

Uncommon winter visitor in small numbers, to beaches and estuaries, from early September to end April.

136. (453) **Great Black-headed Gull *L. ichthyaetus* Pallas**

Common winter visitor in moderate numbers to beaches and estuarine mudflats, from mid-Sept. to end April. Congregations of up to

150 birds are found regularly at Morjim (Pernem) beach and the nearby mouth of the Chapora river.

137. (454) **Brown-headed Gull *L. brunnicephalus* Jerdon**

A common winter visitor in vast numbers. Present along the entire seaboard from mid-Sept. to mid-May. The largest gatherings of over 5000 birds occur on Velsao (Marmagoa) beach.

138. (455) **Black-headed Gull *L. ridibundus* Linn.**

A common winter visitor to the sea-coast and estuaries, in large, but erratically fluctuating numbers. Most of the birds arrive in mid-October and leave towards the end of May. A few non-breeding birds occasionally loiter around through the monsoon. Single-species flocks of close to 10,000 birds (February and December 1983, at Morjim/Pernem beach) were encountered, though this gull is generally much less numerous than *L. brunnicephalus*.

139. (456) **Slender-billed Gull *L. genei* Breme**

Uncommon and irregular winter visitor to beaches and estuaries. This gull is often overlooked, being usually swamped by the vast numbers of other wintering gulls. However, the frequency of sightings has steadily increased over the last 8 years. Records of up to 20 birds date from late August to end February.

140. (458) **Whiskered Tern *Chlidonias hybrida* (Pallas)**

Common but capricious dry season visitor in moderate numbers. Mostly found at freshwater and saline marshes and tanks throughout the coast. The highest numbers (up to 40 birds in one wetland) are encountered during inward migration, in September-October Decreasing numbers make less frequent visits till mid-May. They may suddenly appear in June or even in July, if the rains slacken.

141. (460) **Gull-billed Tern *Gelochelidon nilotica* (Gmelin)**

Common, moderately numerous and widespread dry season visitor to the sea-coast, coastal region and occasionally to freshwater tanks in the midland zone. Found from mid-September to mid-May, up to 85 in a single locality. Oversummering by a few birds is quite common.

142. (462) **Caspian Tern *Hydroprogne caspia* (Pallas)**

An uncommon but regular passage migrant in small numbers. Spring migration lasts from early March to mid-April, autumn passage from mid-Sept. to mid-Dec. At Morjim beach (Pernem), their favourite resting place along Goa's coast, up to 20 birds may assemble in March; autumn migration is less pronounced.

143. (463) **Indian River Tern *Sterna aurantia* J.E. Gray**

Straggler. I have four records of up to three birds from fully saline stretches of the Chapora river and from the freshwater Carambolim lake. These sporadic appearances occurred in Feb., May, September and November in recent years.

144. (464) **Common Tern *S. hirundo* Linn.**

Status uncertain, mainly due to confusion with *S. repressa* when both are in non-breeding plumage and migrating far off-shore. The common tern is, with certainty, a minor participant in the annual spring and post-monsoon mass-migration of the white-cheeked tern. Small numbers are found off and on at estuarine mudflats and beaches during the winter months.

145. (466) **Roseate Tern *S. dougallii* Montagu**

Scarce post-monsoon passage migrant in small numbers. In August and September, singles and small groups of up to 5 birds were observed travelling southward with the steady stream of migrating *S. repressa* or resting on tidal mudflats at the mouth of the Chapora river. An isolated record of a single bird from mid-April could have been of a bird on return migration.

146. (467) **White-cheeked Tern *S. repressa* Hartert**

Passage migrant in very large numbers. Its southward movement is concurrent with and parallel, though closer inshore, to the autumnal

mass migration of *S. anaethetus*. A roughly estimated 15,000 individuals pass between end August and mid-October along Goa's coast, with only a few birds putting in short stop-overs on tidal mudflats in estuaries. The less dramatic return movement from March to June occasionally brings large flocks of up to 500 birds to the Chapora estuary. Roving flocks of up to 300, groups and singles, may be encountered during the SW monsoon.

147. (470) **Black-bellied Tern *S. acuticauda* J.E. Gray**

Stray. I saw three birds in full breeding plumage at the freshwater reservoir on top of a barren lateritic plateau near Sancoale (Marmagoa), in September 1988. Four days later, S.T. Madsen and I saw a group of at least 27 birds at the river mouth at Tadri, near Gokarn (North Kanara, Karnataka), *ca*.105 km to the South.

148. (471) **Brown-winged Tern *S. anaethetus* Scopoli**

A regular off-shore passage migrant in very large but highly fluctuating numbers. Over 28,000 birds were counted during a quantitative survey in 1996. The first of these pelagic terns turn up in the waters off Goa during end August. By mid-September, a massive southward migration sets in, with birds passing several km offshore at a peak rate of over 2,000 per hour. This large-scale movement slows down towards late September and peters out by the first week of October. These terns are known to breed during the SW monsoon on the Vengurla Rocks off Malwan, but not in numbers sufficient to account for the extent of the migration observed off Goa.

149. (474) **Sooty Tern *S. fuscata* Linn.**

Uncommon off-shore passage migrant in smallish numbers. These terns either participate or are simply swept along, in ones and twos, in the annual mass migration of *S. anaethetus*. Immature birds are predominant.

150. (475) **Little Tern *S. albifrons* Pallas**

Annual visitor, in moderate and fluctuating numbers, to beaches, estuaries and, rarely, marshes in the river basins. This tern is more numerous during the first half of the year (with flocks of up to 150 birds) and totally absent only in August.

151. (478) **Large Crested Tern *S. bergii* Lichtenstein**

A common year-round visitor, in considerable numbers, to the entire coastline. Their favourite resting place between foraging trips is at the mouth of the Chapora river, where up to 800 birds may assemble during the dry season. Numbers dwindle to an average of 15 during monsoon. There are indications of a northward spring and southward autumn movement along the coast.

152. (479) **Indian Lesser Crested Tern *S. bengalensis* Lesson**

A common, considerably numerous visitor throughout the year. Found all along the coast, with the main gathering point at the mouth of the Chapora (up to 850 birds in the dry season). Less numerous in the monsoon.

153. (480) **Sandwich Tern *S. sandvicensis* Latham**

Common, considerably numerous year-round visitor to the entire coastline. The most frequented resting place is at the mouth of the Chapora, where loose flocks of at least 500 birds are seen during April. Their numbers drop sharply during the SW monsoon, and are steadily declining over the years. For a preliminary discussion of the status of this species see Lainer (1988).

154. (484) **Indian Skimmer *Rynchops albicollis* Swainson**

Stray. In September 1996, G. Frost and I sighted one adult bird among various terns on a tidal mudflat in the Chapora estuary.

155. (496) **Pompadour Green Pigeon *Treron pompadora* (Gmelin)**

A common resident in considerable numbers, from coastal headlands to the lower slopes of the Western Ghats.

156. (503) **Yellow-legged Green Pigeon *T. phoenicoptera* (Latham)**

Noted by Rane (1982) at the Bondla WS, some time between April and June 1982.

157. (501) **Orange-breasted Green Pigeon *T. bicincta* (Jerdon)**

One was observed in the Cotigao WS, in mid-January 1998.

158. (506) **Green Imperial Pigeon *Ducula aenea* (Linn.)**

Scarce resident of dense wet evergreen forests of the Western Ghats; rarely below 300 m, except in the Cotigao WS.

159. (510) **Imperial Pigeon *D. badia* (Raffles)**

A rather uncommon and moderately numerous resident of the middle and upper slopes of the Sahyadris, where flocks of over 15 birds may be seen. Strays occasionally to some of the remnant patches of evergreen forest in the plateau region.

160. (516) **Blue Rock Pigeon *Columba livia* (Gmelin)**

Non-feral birds are commonly found roosting during the monsoon in an overhanging cliff on the coast of Tirakol (Pernem), on rocky offshore islands, the steep cliffs on the headland of Cabo de Rama (Canacona) and the 60 m high 'ersatz-cliff' of the Anjunem (Sattari) dam, at the base of the Ghats.

161. (521) **Nilgiri Wood Pigeon *C. elphinstonii* (Sykes)**

A rather scarce, erratic visitor, possibly resident. Davidson (1898), writing about N. Kanara, found 'this pigeon is rare ... Mr. Aitken however informs me it is more common further north about Digi on the Portuguese frontier'. I have sighted it no more than 10 times in a pocket of remnant semi-evergreen forest on the scarp of a coastal plateau, between October and December, and twice in dense wet evergreen forest on the crest of the Western Ghats, in May.

162. (530) **Rufous Turtle Dove *Streptopelia orientalis* (Latham)**

Straggler(?) Grubh and Ali (1975) noted it at the BMWS and at Mayem (Bicholim), in November-December 1972. I have seen it thrice on the crest of the Western Ghats and once on Chorao (Tiswadi) Is. in the Mandovi.

163. (534) **Indian Ring Dove *S. decaocto* (Frivaldsky)**

Rane (1982) noted this dove between April and June at the Bondla WS. I recorded four instances of flocks of up to 40 birds appearing on fallow rice-paddies of coastal villages, staying from one week to a month, between Nov.- Feb.

164. (537) **Spotted Dove *S. chinensis* (Scopoli)**

Ubiquitous and very common breeding resident, in very large numbers, of the coastal and midland regions, and the base of the Ghats up to *ca.* 150 m.

165. (541) **Little Brown Dove *S. senegalensis* (Linn.)**

Noted by Grubh and Ali (1975) in or around the Cotigao WS, in Nov. -Dec. 1972.

166. (542) **Emerald Dove *Chalcophaps indica* (Linn.)**

Small numbers of this rather uncommon resident are found in the Sahyadris foothills to *ca.* 200 m., occasionally in pockets of remnant semi-evergreen forest on plateau-scarps, even in close proximity to the sea.

(to be continued)

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POPULATION DENSITIES OF THE BLACKNAPED HARE *LEPUS NIGRICOLLIS NIGRICOLLIS* AT ROLLAPADU WILDLIFE SANCTUARY, KURNOOL DISTRICT, ANDHRA PRADESH[1]

(*With one text-figure*)

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Keywords: blacknaped hare, *Lepus nigricollis nigricollis*, population, census, Rollapadu Wildlife Sanctuary, Andhra Pradesh.

This paper is part of a study carried out on the Indian fox *Vulpes bengalensis* at Rollapadu Wildlife Sanctuary, Kurnool dist., Andhra Pradesh, between July 1994 and April 1995. It describes the census method (actually devised for the fox) used for estimating population densities of the blacknaped hare *Lepus nigricollis nigricollis*. A comparative census was conducted in grazed grassland and ungrazed grassland for the species. The results of the censuses are discussed.

INTRODUCTION

During censuses of the Indian Fox *Vulpes bengalensis* at Rollapadu Wildlife Sanctuary (RWS), Kurnool dist., Andhra Pradesh, we encountered the blacknaped hare *Lepus nigricollis nigricollis* quite regularly during the samplings. We realised that the census technique used for the fox was also suitable in detecting and estimating population densities of the hare. We suggest the use of this census technique for estimating the population densities of hares, since it can be done by an individual and does not need any equipment. Other methods, such as trapping or drive counts, are stressful for the species, and involve more personnel, effort and equipment. In this note, we describe the census method used, and discuss the findings of the study.

STUDY AREA

Rollapadu is 18 km southeast of Nandikotkur (15°58'N and 78°18'E), Kurnool dist., Andhra Pradesh. It lies in the plains between the Nallamalai and Yerramalai hills, at an altitude of about 200 m. The terrain is gently undulating, with predominantly poor red soil. The region is semi-arid with an average annual rainfall of 668 mm, received from both the Southwest and Northeast monsoons. Summer (March to May) peaks at 42°C and winter (November to February) is mild (17°C).

The Sanctuary, covering an area of 6.14 km^2, consists of three grazing and disturbance free grassland enclosures, set up in 1982 to improve the habitat of the great Indian bustard *Ardeotis nigriceps*. These enclosures are surrounded by grazing land and crop fields. The grazed grassland is characterised by short grass (<30cm) with poor ground cover, dominated by *Chrysopogon fulvus, Heteropogon contortus and Melanocenchris jacquemontii*. The ungrazed grassland (enclosures) has taller grasses (*c.* 50 cm.) with good ground cover, dominated by *Heteropogon contortus, Chrysopogon fulvus and Eremopogon foveolatus. Sehima nervosum* (>100 cm), the climax grassland species of gravelly soils of these areas (Dabadghao and Shankarnarayan 1973) has formed pure stands in patches in some areas of the enclosures. The scrubland was dominated by *Carissa spinarum*, *Cassia auriculata*, *C. fistula*, *Phoenix sylvestris*, and *Zizyphus mauritiana*.

The other major fauna of the Sanctuary are lesser florican *Sypheotides indica*, harriers (mostly *Circus pygargus* and *C. macrourus*), blackbuck *Antilope cervicapra*, wolf *Canis lupus*, jackal *Canis aureus* and common Indian monitor

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Varanus bengalensis. For more details on the Sanctuary, see Manakadan and Rahmani (1989, 1993 & 1997).

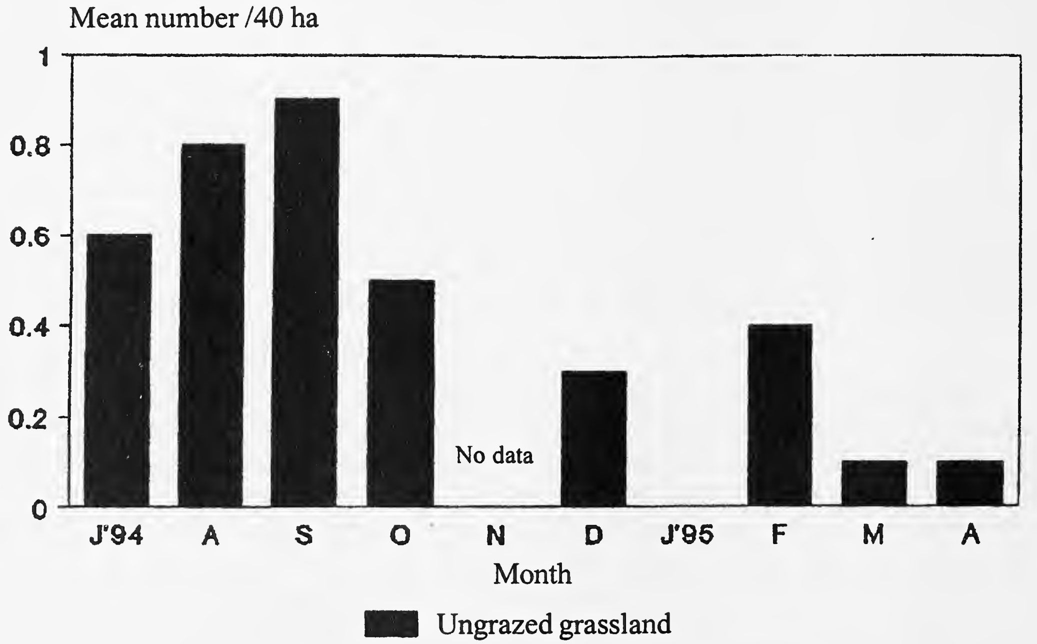
Methodology

Four sites were selected in each of the two habitat types (grazed grassland and ungrazed grassland). The area was thoroughly covered on foot at a constant steady pace, walking in an irregular and generally zigzag manner. Some light noise, such as humming, dragging of feet or tapping the bushes with a stick, was made to flush out hares. On flushing a hare, the direction it ran and the place it stopped was noted to avoid duplication of counts. The micro-habitats (grass/shrub species and their height) in which the animals were encountered were recorded. A unit time (animals/hr) adopted as the basis of the censuses initially, was later modified, as larger areas could be covered in the grazed than ungrazed grassland in the time period, due to the greater visibility in the former. Hence, approximately the same area (*ca*. 40 ha) was covered in the two habitat types during the one hour searches.

Census was done in the evenings once a fortnight from July 1994 to April 1995. Except for one site in the grazing land, which was predominantly open short scrubland, all the other site samples were grassland (grazed or ungrazed). Censuses conducted in tall grass areas (> 100 cm) and dense scrubland were discontinued, as it was apparent that the technique was unsuitable for such habitat types (hares could hide or run off undetected).

Results

Considering the mean values of the four sites for each habitat type, the hare was recorded for all the months in the ungrazed grassland, and only once in the grazed grassland (Fig.1) during



Note: The hare was recorded only once in the grazed grassland

Fig. 1: Density of the blacknaped hare at Rollapadu Wildlife Sanctuary

TABLE 1
CHARACTERISTICS OF HARE SIGHTING SITES

Vegetation Type	No. of sightings	Remarks
Short grass (<30 cm)	11	Nine hares under cover of a bush or tall grass tussock.
Tall grass (>30 cm - *ca.* 50 cm)	15	One hare under cover of a bush.
Medium grass (tall + short)	1	-
Total Sightings	27	-

the wet season (July - October 1995). Data was not collected from November to the first fortnight of December. For the rest of the study period (second fortnight of December till April 1995 - dry season), the hare was not recorded in the grazed grassland, but was occasionally flushed in the ungrazed grassland. Densities of the hare were lower in the dry season than in the wet season. There were no sightings of the hare in the scrubland habitat sampled.

Of the total of 27 sightings (Table 1) in both the habitat types together, the maximum sightings were in tall grass areas (> 30cm to *ca.* 50 cm). Of the eleven sightings in short grass habitat (< 30 cm), in nine cases, the hares were detected under the cover of a bush or tall grass clump, pointing to the necessity of cover in short grass areas.

DISCUSSION

The hare is nocturnal, but not exclusively so (Prater 1980). Hence, most of the sites where the hare was recorded were likely to be 'forms' (regular sleeping spots where the grass is arranged into a hollow) or near such sleeping quarters. Nevertheless, the repeated flushing of hares from the same area could also indicate that these animals held territories. This implies that areas surrounding such 'forms' were their foraging areas.

The population of the hare was low in the grazed grassland, while it was fairly high in the ungrazed grassland in the enclosures. Greater grass biomass, cover from predators, and the absence of human related disturbances, provided better habitat and survival chances for the hare in the enclosures. In the grazing land, fodder was scarce, grass cover minimal, and disturbance from humans heavy, except during summer. Surreptitious hunting of hares also occurred in the grazing lands. In the grazing lands, the hare takes shelter under thorny bushes or in crop fields (where villagers trap them during the harvest). Judging by the lower densities during the hot season, there seems to be some dispersal or wandering of the hare during the hot season. Prater (1980) described greater movement of hares during the hot weather, when the grass is scarce.

The studies show that the hare is largely a grassland species, and has a preference for tall (*ca.* 50 cm) grasslands. Short grass areas, even within the protected enclosures, were not preferred, at least for 'forms'. Almost always, those recorded in short grass stands (*Heteropogon contortus*, *Chrysopogon fulvus*) in the enclosure were found under a bush or an isolated patch of tall grass (*Eremopogon foveolatus*, *Sehima nervosum* or *Cymbopogon caesius*). Very few sightings during these or other studies were obtained from scrub-dominated areas of either the enclosures or grazing lands. Therefore, the spread of scrub, as seen in some areas of the enclosures, could be detrimental to this species.

Our studies show that the census technique devised by us could be used for estimating the populations of the hare (and other similar reclusive species) in grassland and scrubland habitats of up to *ca.* 50 cm.

ACKNOWLEDGEMENTS

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INTER- AND INTRASPECIFIC VARIATION IN THE RESOURCE USE OF BLOSSOMHEADED AND BLUEWINGED PARAKEETS IN SIRUVANI, TAMIL NADU, INDIA[1].

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(*With two text-figures*)

Key words: parakeet, *Psittacula cyanocephala, Psittacula columboides,* resource use, competition.

The blossomheaded (*Psittacula cyanocephala)* and bluewinged (*P. columboides)* parakeets were studied to identify the similarities or differences in their use of resources in the moist deciduous forest at Siruvani foothills, Coimbatore, Tamil Nadu, India. Data on foraging pattern and nest-site characteristics were collected for both the species. Comparisons were made between sexes using data on foraging and between species with data on nest-site characteristics. In both the species, intersexual difference was apparent in the selection of height, canopy and posture. Inter-specific difference was found in the selection of nest orientation and trees with different size class. Both the species in this area showed variation in the resource use to alleviate inter- and intraspecific competition.

Introduction

Studies on resource partitioning mostly demonstrate the ecological differences or similarities between species. Such differences or similarities are found or presumed to indicate the limits of interspecific competition on the number of species that can stably co-exist (Schoener, 1974) and are important in the generation of assembly rules for communities. But most of the attempts to characterise the foraging relations and associated niche characteristic of forest birds have not taken intersexual variation in foraging into account. This is largely due to the difficulties of clearly identifying the sex in the field. Moreover, obtaining sufficient sample sizes for each sex can also be a problem.

Studies of single species or small guilds, however, have shown that foraging patterns of males and females often differ, e.g., in species of woodpeckers (Kilham, 1965 and 1970; Ligon, 1986; Jackson, 1970; Williams, 1980), nuthatches (McEllin, 1979), Muscicapid flycatchers (Bell, 1982) and several warblers (Morse, 1968, 1971 and 1980). Understanding such differences or similarities at inter- and intraspecies level not only increases the understanding of a species niche in an area, but would also help to conserve the species.

A study was carried out on blossomheaded (*Psittacula cyanocephala)* and bluewinged *P. columboides)* parakeet in the moist deciduous forest at the foothills of Siruvani to evaluate how the sexes within a species differ in their use of resources (foraging pattern) and how both species differ in the nest-site selection. These species were selected since both are hole nesters and their ecology is poorly known.

Study area

The Siruvani foothills come within the core area of Nilgiri Biosphere Reserve and lie from 10° 56' to 10° 58' N and 76° 42' to 76° 44' E, at 350 to 650 m above msl. Temperature ranges from 24° C to 38° C during the day time and

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from 18° C to 29° C at night. The average relative humidity is 51%. The area received both southwest and northeast monsoon. The mean annual rainfall is about 842 mm. The river Noyil drains this area. The vegetation type has been classified as "Southern Tropical Moist Deciduous" (Champion and Seth, 1968) and it merges with the Southern Tropical Evergreen Forests at higher elevations in Muthikolam area of Kerala state. The common tree species in the study area are *Lagerstroemia lanceolata*, *Terminalia bellerica*, *T. paniculata*, *Antidesma diandrum*, *Piliostigma malabaricus* and *Bauhinia racemosa*.

Methods

The parakeet species and their sex were determined by the colour of the plumage and calls (Ali and Ripley 1987).

Foraging records. Foraging behaviour was quantified following Holmes *et al.* (1978). Birds were followed and the first attempt to capture food was recorded. Only one foraging record (Initial) was taken from any individual, but it was not possible to prevent or quantify observations of the same individual on different days. For each foraging attempt, the foraging height, method, substrate, plant species from which the food was taken and the type of food were recorded. Foraging attempts were divided into seven height classes (0-2 m, 2-4 m, 4-6 m, 6-8 m, 8-10 m, 10-12 m and >12 m), based on the general physiognomy of the vegetation. All foraging attempts were assigned to ten substrate categories under three major classes: 1. Plant form (tree, shrub), 2. Branches (primary, secondary, tertiary, twigs), 3. Canopy (top, side, middle and lower).

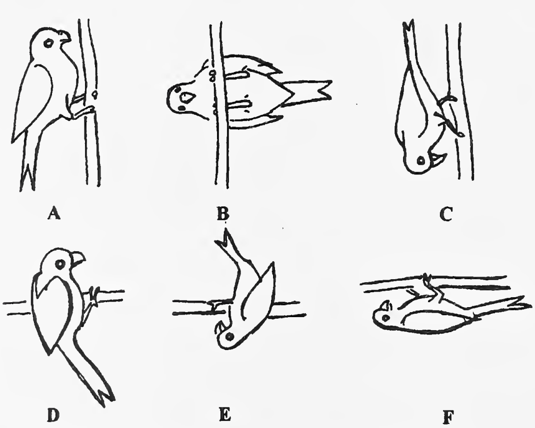

Fig. 1: Posture adopted while feeding by both parakeets

The position or posture of the bird on the branch while feeding was classified based on Remsen and Robinson (1990).

A= "hang-up" on vertical perch, B= "hang-sideways" on vertical perch, C = "hang-down" on vertical perch, D = "hang-up" on horizontal perch, E = "hang-down" on horizontal perch, and F = "hang-upside down" on horizontal perch. All these categories were based on how a bird positions itself on a branch to acquire its food (Fig. 1).

Data were mostly collected within the first four hours after sunrise. Each foraging attempt was considered as an observation for all analyses.

Phenological records. The phenology of dominant food plant species was recorded to assess food availability during the study period. Ten individuals of each plant species were marked and monitored every 15 days. All the vegetative and reproductive phases were assigned in percentage according to their availability.

Nest-site selection. Intensive nest search was made throughout the area. A hole was confirmed to be occupied if adults were seen to perform activities related to breeding near the nest. Data were collected on nest height (height of the nest from ground level), tree species used for nesting, Girth at breast height (Gbh) of nesting tree, Girth at nest level, nest hole diameter, nest hole depth and orientation of the nest hole on the tree.

Statistical analyses. The χ^2 test of independence was used to identify the variation in the resource use between species and sexes.

Mann-Whitney *U* test was performed for nest-site variables.

Results

Four types of food items i.e. fruit, seed, flower and sprouting leaves, were recorded for both the parakeets. Flowers and nectar were the predominant food for both the sexes and species. No parakeets showed any variation in the type of food used (Table 1).

Table 1
FOOD ITEMS OF BLOSSOMHEADED AND BLUEWINGED PARAKEETS (%)

Species	Sex	Fruits	Seeds	Flowers	Leaves
Blossomheaded	Male	8	6	65	21
Parakeet	Female	8	9	65	18
Bluewinged	Male	8	10	49	33
Parakeet	Female	3	18	61	18

Blossomheaded Parakeet: In all, 352 feeding observations of blossomheaded parakeet were made, of which the male and female observations were 189 and 163 respectively.

Both the sexes preferred trees to shrubs. Within the tree, both the sexes preferred only the top and side canopy. The difference in canopy preference between the sexes was not significant. No bird was ever observed feeding in the lower canopy. In general, twigs were preferred to the same extent by both sexes (Table 2).

Of the six positions or postures (A, B, C, D, E and F), the male and female used mostly "D" and "E" type respectively. Interestingly, "A" was the next type preferred by both the sexes (Table 3). Position "F" was the least preferred by both the sexes. Overall, the posture used differed significantly between sexes ($\chi^2 = 41.1$, $P<0.05$). Interestingly, it differed significantly between the months in both male ($\chi^2 = 30.09$ $P<0.05$) and female ($\chi^2 = 42.9$ $P<0.05$). In height use, though sexes did not differ significantly over different months, overall they showed a significant difference ($\chi^2 = 20.40$, $P<0.05$). In general, male and female highly preferred 6-10 m height class. The female showed a higher preference for 8-10 m height class (61%) over the male (44%) while the male showed higher preference for the >10 m height class (30%) than the female (21.5%).

Bluewinged parakeet: Altogether 492 foraging observations were made for bluewinged parakeet, of which 287 observations were on male and 205 on female. Both males and females of bluewinged parakeet preferred only trees. No foraging was observed on shrubs. Both the sexes selected only top and side canopy of the trees. The top canopy was highly preferred, while the middle and lower canopies were least preferred by both the sexes. Sexes showed a similarity in canopy preference.

Table 2
PERCENT FREQUENCY OF SUBSTRATE USED BY BLOSSOMHEADED PARAKEET

Sex	Month	Tree	Shrub	Canopy			Branches			
				Top	Side	Middle	Primary	Secondary	Tertiary	Twigs
Male	Dec	94	6	78	16	6	12	30	7	51
	Jan	90	10	34	66	0	0	0	49	51
	Feb	96	4	39	61	0	0	0	27	73
	Overall	94	6	53	44	3	5	12	23	60
Female	Dec	96	4	78	15	7	14	28	15	43
	Jan	92	8	55	45	0	0	0	58	42
	Feb	96	4	18	82	0	0	0	18	82
	Overall	95	5	47	50	3	10	10	20	60

TABLE 3
PERCENT FREQUENCY OF HEIGHT AND POSTURE USED BY BLOSSOMHEADED PARAKEET

Sex	Month	Posture used						Height class (m)						
		A	B	C	D	E	F	0-2	2-4	4-6	6-8	8-10	10-12	>12
Male	Dec	72	0	0	11	17	0	0	0	0	14	27	8	51
	Jan	26	5	13	31	20	5	10	0	2.6	36	46	5.4	0
	Feb	19	18	0	57	6	0	4	0	0	22	58	16	0
	Overall	28	12	4	43	11	2	3.5	0	0.5	22	44	11	19
Female	Dec	46	15	15	9	15	0	0	7	3.5	7	26	3.5	53
	Jan	47	6	14	19	8	6	8	0	0	25	61	6	0
	Feb	7	29	0	7	57	0	0	4	0	6	90	0	0
	Overall	24	20	6	10	38	2	2	4.3	1.2	10	61	3.5	18

A = "hang-up" on vertical perch; B = "hang-sideways" on vertical perch; C = "hang-down" on vertical perch; D = "hang-up" on horizontal perch; E = "hang-down" on horizontal perch, and F = "hang-upside down" on horizontal perch.

Both the sexes preferred twigs and no significant difference was observed in this respect (Table 4).

The position (A, B, C, D, E and F) used showed significant difference between sexes ($\chi^2 = 20.38$, P= 0.001) overall, and it differed even monthwise for both male ($\chi^2 = 17.83$, P<0.05) and female ($\chi^2 = 25.96$, P<0.05). Of the six types of positions, the male did not perform type "F" but the female opted for all the types. Interestingly, type "B" was the second preference of both the sexes (Table 5). Regardless of sex, the bluewinged parakeet mostly preferred > 8 m height class throughout the period (Table 5). They were not observed feeding on 0-2 m category. Regardless of months, sexes significantly differed in height selection ($\chi^2 = 22.5$, P<0.05). Male showed a higher preference (43%) for >10 m height class than the female (29%).

Nest-site characteristics. In all 12 nests of blossomheaded and 11 nests of bluewinged parakeet were located. Tree species namely *Grewia tillifolia*, *Tectona grandis*, *Albizia odoratissima*, *Lagerstroemia lanceolata and Melia dubia* were used for nesting by both the species. The majority of bluewinged parakeet nests were found in *Grewia tillifolia* (64%)

TABLE 4
PERCENT FREQUENCY OF SUBSTRATE USED BY BLUEWINGED PARAKEET

Sex	Month	Canopy			Branches			
		Top	Side	Middle	Primary	Secondary	Tertiary	Twigs
Male	Dec	79	15	6	13	27	12	48
	Jan	79	21	0	0	0	16	84
	Feb	89	11	0	0	5	24	71
	Overall	81	15	4	4	7	19	70
Female	Dec	80	13	7	12	25	16	47
	Jan	78	22	0	0	0	26	74
	Feb	49	51	0	0	0	9	91
	Overall	72	26	2	8	19	15	58

TABLE 5
PERCENT FREQUENCY OF HEIGHT AND POSTURE USED BY BLUEWINGED PARAKEET

Sex	Month	Posture used						Height class (m)					
		A	B	C	D	E	F	2-4	4-6	6-8	8-10	10-12	>12
Male	Dec	57	9	9	9	16	0	4	2	10	27	5	52
	Jan	45	39	11	5	0	0	0	11	26	39	24	0
	Feb	71	16	0	10	3	0	0	0	23	60	17	0
	Overall	60	20	6	8	6	0	3	3	15	36	10	33
Female	Dec	46	15	15	9	15	0	7	4	7	27	4	51
	Jan	48	33	13	4	1	1	0	11	26	44	19	0
	Feb	18	51	20	0	11	0	0	0	31	51	18	0
	Overall	40	36	15	3	5	1	2	6	22	41	15	14

A = "hang-up" on vertical perch; B = "hang-sideways" on vertical perch; C = "hang-down" on vertical perch; D = "hang-up on horizontal perch; E = "hang-down" on horizontal perch, and F = "hang-upside down" on horizontal perch.

followed by *Melia dubia* (27%). Similarly, blossomheaded parakeet nests were mostly on *Grewia tillifolia* (42%) and *Tectona grandis* (42%).

The bluewinged parakeet preferred to select holes at higher places (7.88 ± 3.23 m) than blossomheaded parakeet (6,44 ± 3.23 m). Moreover, bluewinged parakeets select taller and bigger trees for nesting than the blossomheaded (Table 6). Both the species showed difference in the nest orientation (Fig 2). Among the four

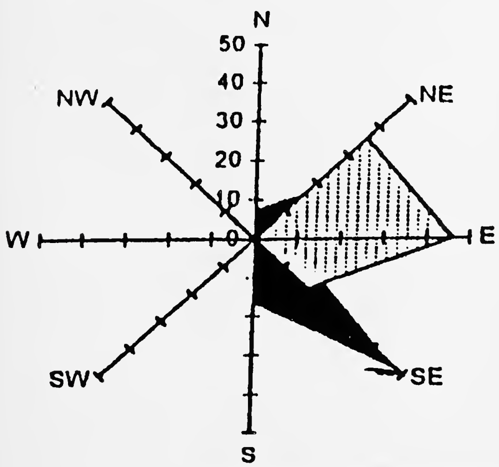

Fig.2: Orientation of nest holes of parakeets

TABLE 6
NEST-SITE CHARACTERISTICS OF BLOSSOMHEADED PARAKEET AND BLUEWINGED PARAKEET

Variables	Blossomheaded Parakeet (n=12)		Bluewinged Parakeet (n=11)	
Plant species	Frequency	%	Frequency	%
Grewia tillifolia	5	42	7	64
Tectona grandis	5	42	1	9
Albizia odoratissima	1	8	0	0
Lagerstroemia lanceolata	1	8	0	0
Melia dubia	0	0	3	27
	12		11	
	Mean	SD	Mean	SD
Nest height (m)	6.44	±3.23	7.88	±3.23
Nest tree height (m)	13.46	±2.34	14.49	±1.31
Nest tree DBH (m)	1.5	±0.52	1.81	±0.32
Diameter at nest level (m)	1.06	±0.48	1.10	±0.30

variables (nest height, nest tree height, tree girth at breast height (gbh) and girth at nest hole level), significant difference was observed between the two species only in tree gbh (U = -2.4, P=0.01).

Discussion

The bluewinged and the blossomheaded parakeet showed a preference for sprouting leaves and flowers (nectar). Ali and Ripley (1987) have reported that grains and fruits are the preferred food of blossomheaded and bluewinged parakeet, and they also eat buds, petals and nectar. Balasubramanian (1986) reported that the roseringed parakeet feeds on leaves in the absence of fruits. During this study, fruit availability was low. The observed preference for flowers and sprouting leaves is, therefore, a strategy to exploit an alternative food resource.

Intersexual differences. Of the six dimensions (food, plant form, height, canopy, branches and posture) used, there was significant difference in height and posture between sexes. In the case of foraging posture, significant difference was shown by both the species. The difference was notable even between different months. Parakeets normally forage in flocks and feed very close to each other on the same plant. If any one of them is disturbed or starts flying, all flee immediately. The availability of perches (twigs or branches) near the resources are insufficient to accommodate all the flock members, and hence, each individual chooses different foraging postures. Normally, horizontal perches and sitting upright seem to be more comfortable than the vertical or other postures. As the available space is occupied by the first arrival or on hierarchical basis, other individuals are forced to use the next available perch. This could be to avoid predation, or as a result of their social behaviour.

In height use, the male preferred greater height classes than the female. For both the sexes, the resources were the same, but the way in which they were exploited was different. For example, both the sexes preferred flowers and sprouting leaves available mostly on the top and side canopies, but utilised the resources at different height classes and by different methods. The differences in sexes can be attributed as a means to alleviate intraspecific competition (Rand, 1952 and Selander, 1966). Another reason could be that they forage near their centres of activity, which differ between sexes in the breeding season for passerine birds. During the breeding season, males are more conspicuous and effective in long distance communication with females when they are at greater heights and feed near their song perches; likewise, females forage in lower strata near nests (Morse, 1968 and 1980). Though the result supports both the hypotheses, the "centres of activity" hypothesis is meant perhaps only for breeding individuals and passerines. But in the present study, data was collected on both breeding and non-breeding individuals of non-passerines. It may be noted that inclusion of both breeders and non breeders would probably distort the result. Thus our results would be meaningful if the reason for differences in the resource use between sexes is intraspecific competition, rather than the centres of activity.

Inter-specific differences. Cavity nesters pose a unique habitat problem. Obligate cavity-nesting is generally associated with intra- and interspecific competition for nest sites (Collias and Collias, 1984 and Nilsson, 1984) and such competition was found to result in bird species selecting nest holes that differed in height, size, shape and orientation (Edington and Edington 1972, Van Balen *et al.* 1982). In their nest-site requirements, both species of parakeets differed in the selection of plant species in terms of their size. The bluewinged showed some consistency in selecting a particular plant species, as well as size of the tree. The selection of *Grewia tillifolia* by the majority for nesting can be attributed to its greater height and spread. The bluewinged parakeet starts nesting earlier than the blossomheaded, therefore the probability of its selecting the most suitable holes for nesting was greater than the latter.

In conclusion, it may be stated that differences in the selection of nest height, orientation, mature tree and time of breeding between these two congeneric parakeets may

enable them to coexist in this moist deciduous habitat.

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FISHES OF GADANA RIVER IN KALAKKAD MUNDANTHURAI TIGER RESERVE[1]

M. ARUNACHALAM AND A. SANKARANARAYANAN[2]

Key words: Kalakkad Mundanthurai Tiger Reserve, fish diversity, Western Ghats

Streams in Gadana river basin located in the buffer zone of Kalakkad Mundanthurai Tiger Reserve were surveyed during January 1997-98. Thirty-one species belonging to 5 orders, 12 families and 22 genera were recorded, of which *Hypselobarbus dobsoni, Pseudambassis ranga, Puntius sarana orphoides* and *Glyptothorax madraspatnum* were first records for this river basin.

INTRODUCTION

Documentation and conservation are the current areas of concern for fish biologists. Gadana river and its tributaries which flow in the buffer zone of Kalakkad Mundanthurai Tiger Reserve form a sub-basin of a major river called Tamiraparani in the southeastern Western Ghats. Tamiraparani river basin constitutes the Gadana river, Ramanadhi, Pachayar, Chittar, Manimuthar and Jambunadhi. However, the river systems of Tamiraparani sub-basins were completely unexplored. Silas (1953) described a new species of *Puntius arulius tambiraparniei* from Tamiraparani river. Johnsingh and Wickram (1987) reported the freshwater fishes from Kalakkad Mundanthurai Wildlife Sanctuary. Rema Devi *et al.* (1997) gave a list of fishes from Tamiraparani river system. To date there is no record of fishes from the sub-basins of Tamiraparani river. The present survey is part of a programme on the fish diversity in Western Ghats streams.

STUDY AREA

Gadana river, with its tributaries, forms a sub-basin in the Tamiraparani river basin. This river originates (8° 48' N lat., 77° 19' E long.) from Alwarkurichi and Kadayam ranges of Western Ghats at an altitude of 1,564 m above msl and flows down the eastern slopes of Western Ghats. During flooding, this river confluences with the Tamiraparani river. The perennial Gadana river is drained by three tributaries, viz. Pampar, Kallar and Iluppaiyar. Pampar and Kallar are dammed and Iluppaiyar stream joins the Gadana river below the reservoir. Below the confluence of Iluppaiyar, the river traverses through plains, draining many villages adjacent to the river for about 12 km south-eastwards, before joining Tamiraparani river near Thiruppudai Marudur village in Ambasamudram taluk. The length of Gadana river from its origin to the confluence is about 33 km.

MATERIAL AND METHODS

Fishes were collected from several localities in the three tributaries using drag net, various mesh sizes of gill nets and scoop nets. The colour, spots if any, and other characters of the fishes caught were noted and the specimens were preserved in 10% formalin.

Systematic Account

Among the 31 species recorded from Gadana river, a systematic account of 23 species is given below; detailed accounts on 8 species (*Hypselobarbus dobsoni*, *Puntius arulius tambiraparniei*, *Anguilla bengalensis*, *Puntius sarana orphoides*, *Ompok bimaculatus*, *Bhavania australis*, *Nemacheilus triangularis* and *Glyptothorax madraspatnum* have been published earlier (CAMP workshop 1997; Arunachalam and Sankaranarayanan in press).

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1. ***Labeo calbasu*** (Hamilton-Buchanan)

1822, *Cyprinus calbasu* Ham.-Buch. Fishes of Ganges: 297, 387 pl. 2, fig. 33 (type locality: rivers and ponds of Bengal and in the Western provinces)

Material: 2 examples; 98 mm to 124 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Pakistan, Nepal, Myanmar, Thailand and Yunnan (South China).

Status: Not common in Gadana river.

Remarks: It attains a standard length of 90 cm (Talwar and Jhingran 1991). In our collections, we recorded a maximum standard length of 124 mm.

2. ***Puntius amphibius*** (Valenciennes)

Capoeta amphibia Valenciennes, 1842, Hist. nat. Poiss., 16: 182, pl. 478 (type locality: Bombay).

Material: 3 examples; 32 mm to 84 mm from one locality (Pampar) were examined.

Distribution: Pampar. First record. Elsewhere: Orissa, Madhya Pradesh, Rajasthan and Sri Lanka.

Status: Not common in Gadana river.

Remarks: It attains a standard length of 200 mm (Talwar and Jhingran 1991). But we recorded a maximum standard length of 84 mm.

3. ***Puntius bimaculatus*** (Bleeker)

Gnathopogon bimaculatus Bleeker, 1844, *Verh. Nat. Holl. Maatsch. Haarlem,* (2) 20: 17, pl. 4, fig. 1 (type locality: Ceylon)

Material: 4 examples; 36 mm to 48 mm from two localities (Pampar and Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Bangalore.

Status: Common in Gadana river.

Remarks: It attains a standard length of 100 mm (Talwar and Jhingran 1991). But we recorded a maximum standard length of 48 mm.

4. ***Puntius dorsalis*** (Jerdon)

1849, *Systomus dorsalis* Jerdon, Madras J. Lit & Sci 15: 314 (type locality: tanks and rivers in the neighbourhood of Chennai).

Material: 3 examples; 48 mm to 98 mm from three localities were examined.

Distribution: Gadana river. First record. Elsewhere: Cauvery and Krishna river systems and Sri Lanka.

Status: Common in Gadana river.

Remarks: It attains a standard length of 24 cm (Talwar and Jhingran 1991). We recorded a maximum standard length of 98 mm.

5. ***Puntius filamentosus*** (Valenciennes)

1844, *Leuciscus filamentosus* Valenciennes Hist. nat. Poiss, 17: 96 pl. 492 (type locality: Alleppey, Kerala State)

Material: 3 examples; 42 mm to 58 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Goa, Karnataka and Tamil Nadu, Sri Lanka and Thailand.

Status: Not common in Gadana river.

Remarks: Attains a total length of 180 mm (Jayaram, 1991). In our collections we recorded a maximum total length of 58 mm.

6. ***Puntius sarana sarana*** (Hamilton-Buchanan)

1822, *Cyprinus sarana* Ham.-Buch. Fishes of Ganges: 307, 388 (type locality: ponds and rivers of Bengal).

Material: 4 examples; 72 mm to 111 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Afghanistan, Pakistan, throughout India except peninsula south of Krishna river. Nepal, Bangladesh and Myanmar.

Status: Common in Gadana river.

Remarks: It attains a standard length of 31 cm (Talwar and Jhingran 1991). In our collections we recorded a maximum size of 111 mm in standard length.

7. ***Puntius sarana subnasutus*** (Valenciennes)

1842, *Barbus subnasutus* Val. Hist. nat. Poiss., 16:16:154 (type locality: Pondicherry)

Material: 5 examples; 74 mm to 111 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Krishna and Cauvery river systems and Kerala in Peninsular India.

Status: Common in Gadana river.

Remarks: It attains a standard length of 250 mm (Talwar and Jhingran 1991). But we recorded a maximum standard length of 111 mm.

8. ***Puntius ticto*** (Hamilton-Buchanan)

1822, *Cyprinus-ticto* Ham.-Buch. Fishes of Ganges. 314, 398 pl. 8, fig. 87 (type locality: Southeastern parts of Bengal

Material: 6 examples; 48 mm to 52 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. F'rst record. Elsewhere: Pakistan, lower Swat river drainage; India, Nepal, Sri Lanka, Bangladesh, Myanmar and Thailand.

Status: Not common in Gadana river.

Remarks: It attains a standard length of 100 mm (Talwar and Jhingran 1991). In our collections we recorded a maximum standard length of 52 mm.

9. ***Puntius vittatus*** Day

1865, *Puntius vittatus* Day Proc. Zool. Soc. Lond: 303 (type locality: Cochin, Kerala)

Material: 10 examples; 23 mm to 26 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Goa, Karnataka, Kerala, Tamil Nadu, Kutch, Bihar, Rajasthan and Sri Lanka.

Status: Common in Gadana river.

Remarks: It attains a total length of 25 mm (Jayaram 1991). We recorded a maximum total length of 26 mm.

10. ***Salmostoma clupeoides*** (Bloch)

1782, *Cyprinus clupeoides* Bloch, Naturges ausland Fische 12:49 pl. 408, fig. 2 (type locality: "Indian ocean" evidently not the Ocean but a freshwater body).

Material: 5 examples; 62 mm to 84 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Eastern and Western Ghats, Maharashtra, Madhya Pradesh, Gujarat and Myanmar.

Status: Not common in Gadana river.

Remarks: *Salmostoma clupeoides* is not common in Gadana river. It attains a standard length of 15 cm (Talwar and Jhingran 1991). We recorded a maximum standard length of 84 mm.

11. ***Amblypharyngodon microlepis*** (Bleeker)

1853, *Leuciscus microlepis* Bleeker Verh. Batav Genoot. Kunst. Wet., 25:141 (type locality: Bengal).

Material: 5 examples; 51 mm to 76 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Uttar Pradesh, Bihar, West Bengal, Orissa, Andhra Pradesh, Tamil Nadu and Kerala.

Status: Not common in Gadana river.

Remarks: It attains a standard length of 100 mm (Talwar and Jhingran 1991). But in our collections we recorded a maximum standard length of 76 mm.

12. ***Danio aequipinnatus*** (McClelland)

1839, *Perilampus aequipinnatus* Mcclelland, Asiat. Res. 19(2): 393 pl. 60, fig. 1 (type locality: Assam)

Material: 10 examples; 48 mm to 84 mm from three localities were examined.

Distribution: Gadana river. First record Elsewhere: India, Sri Lanka, Bangladesh, Myanmar and Thailand.

Status: Common in Gadana river. Inhabits hill streams up to 300 m above msl.

Remarks: It attains a standard length of 150 mm (Talwar and Jhingran 1991). But we only recorded a maximum standard length of 84 mm.

13. ***Esomus themacois*** (Valenciennes)

1842, *Nuria thermocois* Val. Hist. nat. Poiss. 16: 238 pl. 472 (type locality: hot spring at Kanniya, Sri Lanka).

Material: 3 examples; 42 mm to 83 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Sri Lanka.

Status: Not common in Gadana river.

Remarks: It attains a standard length of 120 mm (Talwar and Jhingran 1991). But we recorded a maximum standard length of 83 mm.

14. ***Parluciosoma daniconius***
(Hamilton-Buchanan)

1822, *Cyprinus daniconius* Ham.-Buch. Fishes of Ganges: 327, 391 pl. 15, fig. 89 (type locality: rivers of Southern Bengal)

Material: 10 examples; 42 mm to 103 mm from Pampar and Thoniyar were examined.

Distribution: Pakistan, India, Sri Lanka, Bangladesh, Myanmar and Thailand, Mekong river basin.

Status: Common in Gadana river, prefers running water.

Remarks: It attains a standard length of 100 mm (Talwar and Jhingran 1991). We recorded a maximum standard length of 103 mm.

15. ***Garra mullya*** (Sykes)

1841, *Chondrostoma mullya,* Trans. Zool. Soc. Lond. 2: 359, pl 62, fig. 3 (type locality: Bheema river at Daunde, near Pune).

Material: 10 examples; 42 mm to 122 mm from three localities were examined.

Distribution: Gadana river. First record. Elsewhere: India except Assam and the Himalaya.

Status: Common in Gadana river.

Remarks: It grows upto 170 mm in standard length (Talwar and Jhingran 1991). We recorded a maximum standard length of 122 mm.

16. ***Lepidocephalus thermalis***
(Valenciennes)

1846, *Cobitis thermalis* Val. Hist. nat. Poiss., 18: 78 (type locality: Malabar)

Material: 2 examples; 35 mm to 42 mm from two localities (Pampar and Thoniyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Kerala, Karnataka, Maharashtra and Sri Lanka.

Status: Common in Gadana river.

Remarks: *Lepidocephalus thermalis* attains a standard length of 80 mm (Talwar and Jhingran 1991). We recorded a standard length of 42 mm.

17. ***Mystus armatus*** (Day)

1865, *Hypselobagrus armatus* Day, Proc. Zool. Soc. Lond: 289 (type locality: Cochin)

Material: 3 examples; 42 mm to 68 mm from two localities (Pampar and Thoniyar) were examined.

Distribution: Gadana river: First record. Elsewhere: Wynaad hills, Western Ghats and Nagaland; probably also lower Myanmar.

Status: Common in Gadana river.

Remarks: *Mystus armatus* attains a standard length of 145 mm (Talwar and Jhingran 1991). But we recorded a maximum standard length of 68 mm only.

18. ***Aplochelius lineatus*** (Valenciennes)

1846, *Panchax lineatum* Val. Hist. nat. Poiss., 18: 381 (type-locality: Peninsula, India)

Material: 9 examples; 33 mm to 60 mm from two localities (Pampar and Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Western and Southeastern regions.

Status: Common in Gadana river.

Remarks: It attains a length of 100 mm (Day 1878). But we recorded a maximum standard length of 60 mm only.

19. ***Pseudambassis ranga***
(Hamilton-Buchanan)

1822, *Chanda ranga* Ham.-Buch. Fishes of Ganges 113, 371 pl. 16, fig 38 (type locality: freshwaters of all Gangetic provinces).

Material: 3 examples; 32 mm to 38 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Pakistan, India, Bangladesh, Myanmar, Thailand and Malaysia.

Status: Not common in Gadana river

Remarks: It attains a standard length of 70 mm (Talwar and Jhingran 1991). But we recorded a maximum standard length of 38 mm.

20. ***Etroplus maculatus*** (Bloch)

Chaetodon maculatus Bloch, 1785, Syst. Ichth. Pl. 427, fig. 2 (type locality: India)

Material: 5 examples; 30 mm to 44 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: India: Orissa, Andhra Pradesh, Tamil Nadu, Kerala and Sri Lanka.

Status: Not common in Gadana river.

Remarks: It attains a standard length of 80 mm (Talwar and Jhingran 1991). But in our collections we recorded a maximum standard length of 44 mm.

21. ***Oreochromis mossambica*** (Peters)

1852, *Chromis (Tilapia) mossambicus* Peters, Montab, Akad, Wiss., Berlin: 681 (type locality: Mozambique)

Material: 6 examples; 42 mm to 240 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: East Africa; introduced in India, Pakistan and Sri Lanka.

Status: Common in Gadana river.

Remarks: In our collections we recorded a maximum standard length of 240 mm.

22. ***Macropodus cupanus*** (Valenciennes)

1831, *Polyacanthus cupanus,* Hist. nat. Poiss., 7: 357 (type locality: Ariancoupon river at Pondicherry)

Material: 2 examples; 28 mm to 32 mm from one locality (Iluppaiyar) were examined.

Distribution: Gadana river. First record. Elsewhere: Eastern India, Sri Lanka, Western Myanmar, Malay peninsula and Sumatra.

Status: Not common in Gadana river.

Remarks: It attains a standard length of 75 mm (Talwar and Jhingran 1991). But we recorded a maximum standard length of 32 mm.

23. ***Mastacembelus armatus*** (Lacepede)

1800, *Macrognathus armatus* Lacepede, Hist. nat. Poiss, 2: 286 (type-locality: not known)

Material: 2 examples; 140 mm to 510 mm from three localities were examined.

Distribution: Gadana river. First record. Elsewhere: Pakistan, India, Sri Lanka, Nepal, Myanmar through Thailand and Malaya to Southern China.

Status: Common in Gadana river.

Remarks: It attains a standard length of 61 mm (Talwar & Jhingran 1991). In our collections we recorded a maximum size of 510 mm.

RESULTS AND DISCUSSION

From our study, it is evident that Gadana river drainage system is rich in fish diversity. A total of 32 species belonging to 21 genera were recorded from each locality of the three tributaries (Table 1). Of all these three localities, Pampar and Iluppaiyar are less disturbed. The banks of the Iluppaiyar stream are unstable due to farming activities. Even though Iluppaiyar stream is disturbed beyond the riparian zone, the fish species richness is high compared to the other two streams. This may be due to the presence of rich riparian strips.

Puntius sarana orphoides, Pseudambassis ranga, Glyptothorax madraspatnum are comparatively rare and *Hypselobarbus dobsoni* occurs in great abundance in Gadana river, but they are not recorded in other river systems constituting the Tamiraparani river basin.

Puntius sarana orphoides was originally described by Valenciennes from Java. Menon (1963) recorded this subspecies from Manipur. This species was first reported from Western Ghats of South India. Menon (1992) recorded *Hypselobarbus dobsoni* from the Krishna river

TABLE 1
FISH SPECIES RECORDED IN GADANA RIVER

Species	Pampar	Kallar	Iluppaiyar
I Order: Anguilliformes			
i) Family: Anguillidae			
Genus: *Anguilla*			
1. *Anguilla bengalensis bengalensis*	1	1	1
II Order: Cypriniformes			
ii) Family: Cyprinidae			
Genus: *Hypselobarbus*			
2. *Hypselobarbus dobsoni**	4	4	4
Genus: *Labeo*			
3. *Labeo calbasu*	-	-	2
Genus: *Puntius*			
4. *Puntius amphibius*	1	-	2
5. *Puntius bimaculatus*	2	3	4
6. *Puntius dorsalis*	2	2	2
7. *Puntius arulius tambiraparniei*	2	2	4
8. *Puntius filamentosus*	-	-	3
9. *Puntius sarana orphoides***	-	-	4
10. *Puntius sarana sarana*	2	1	3
11. *Puntius sarana subnasutus*	2	5	6
12. *Puntius ticto*	-	-	10
13. *Puntius vittatus*	3	2	10
Genus: *Salmostoma*			
14. *Salmostoma clupeoides*	-	-	5
Genus: *Amblypharyngodon*			
15. *Amblypharyngodon microlepis*	-	-	5
Genus: *Danio*			
16. *Danio aequipinnatus*	3	3	4
Genus: *Esomus*			
17. *Esomus thermoicos*	-	-	3
Genus: *Parluciosoma*			
18. *Parluciosoma daniconius*	6	4	2
Genus: *Garra*			
19. *Garra mullya*	4	3	3
iii) Family: Balitoridae			
Genus: *Bhavania*			
20. *Bhavania australis*	2	-	-
Genus: *Nemacheilus*			
21. *Nemacheilus triangularis*	2	2	5
iv) Family: *Cobitidae*			
Genus: *Lepidocephalus*			
22. *Lepidocephalus thermalis*	1	1	2
III) Order: Siluriformes			
v) Family: Bagridae			
Genus: *Mystus*			
23. *Mystus armatus*	1	2	2
vi) Family: Siluridae			
Genus: *Ompok*			
24. *Ompok bimaculatus*	-	-	2
vii) Family: Sisoridae			
Genus: *Glyptothorax*			
25. *Glyptothorax madraspatnum**	1	-	2
IV) Order: *Cyprinodontiformes*			
viii) Family: Aplocheilidae			
Genus: *Aplocheilus*			
26. *Aplocheilus lineatus*	2	5	6
V) Order: Perciformes			
ix) Family: Ambassidae			
Genus: Pseudambassis			
27. *Pseudambassis ranga**	-	-	3
x) Family: Cichilidae			
Genus: *Etroplus*			
28. *Etroplus maculatus*	-	-	5
Genus: Orechromis			
29. *Orechromis mossambica*	2	2	6
xi) Family: Belontiidae			
Genus: *Macropodus*			
30. *Macropodus cupanus*	-	-	2
xii) Family: Mastacembelidae			
Genus: *Mastacembelus*			
31. *Mastacembelus armatus*	1	1	1

* First record for Tamirabarani river basin.
** First record for Western Ghats.

drainage. It extends its range to Tamil Nadu part of Western Ghats as a dense population. *Glyptothorax madraspatnum* has so far been reported from Aralam Wildlife Sanctuary, Kerala by Shaji *et al.* (1995). The present survey reports it for the first time in Tamiraparani river basin. *Pseudambassis ranga* was originally described in the Gangetic Provinces by Hamilton-Buchanan (1822). Later Ajithkumar and Vijayan (1988) recorded this species from Keoladeo National Park,

Bharatpur, Rajasthan. We are reporting it from Gadana river for the first time.

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STATUS OF THE BLACK SHAHEEN OR INDIAN PEREGRINE FALCON *FALCO PEREGRINUS PEREGRINATOR* IN SRI LANKA[1]

HERMANN DÖTTLINGER[2] AND THILO W. HOFFMANN[3]

(*With one text-figure*)

Key words: Indian peregrine falcon, shaheen falcon, *Falco peregrinus peregrinator,* Sri Lanka, nest sites, population estimate

A literature survey and study of museum specimens was carried out to register all locations of sightings for the subspecies *Falco peregrinus peregrinator* in Sri Lanka. In 1995 and 1996, field surveys were conducted to find occupied nest sites. Data of nest site distances were used for the calculation of a preliminary population estimate. Comparison of the estimated population density of 40 breeding pairs in Sri Lanka was made with sample data from southern Germany. In spite of no obvious signs of food shortage, or nest site limitations, the estimated breeding population of Sri Lanka is very low.

INTRODUCTION

The Indian peregrine falcon (*Falco peregrinus peregrinator*) has always been regarded as a very uncommon and shy bird, and it is very rarely met with by amateur birdwatchers (Ali and Ripley 1968, Legge 1878-80). Thus data from Sri Lanka are scarce. It is generally acknowledged that it is a breeding resident in Sri Lanka (Henry 1971, Lamsfuss 1996b, Wait 1971) but estimates of the total population have only been made on the basis of data from single sight records.

MATERIAL AND METHOD

In 1995 and 1996, field surveys were conducted to determine the current status. This was necessary as a prerequisite for a research project which is presently ongoing, supported by the Ceylon Bird Club and the Department of Wildlife Conservation. Before starting any field work, all available historical data were collected to gain a preliminary impression and to find a possible starting point for the field surveys. The data gathered from an intensive literature survey as well as from labels on museum skins (Natural History Museum, Tring; Bombay Natural History Society Museum; the Museum of Zoology, University of Michigan) in 1994 are shown in Table 1. Equipped with this data, the first brief field search was carried out from March 17 to 26, 1995. The shaheen falcons display greatest activity during early courtship which is believed in Sri Lanka to be from February to June (Henry 1971). To locate nest sites and the falcons, road side searches were thought to be best. Every rock face along a road was checked for white marks and scanned with binoculars. The white marks result from excreta of falcons roosting at the same spot in a rock face and can be seen fairly well from a distance. When white marks (droppings) were spotted, the rock face was marked on the map and the geographical data were recorded by Geographical Position System (GPS). Approximately one to two hours were then spent on direct observation to determine the presence of shaheen falcon. The main purpose of this road side count was to find nest sites occupied by breeding pairs for further research at a later date. Results of the 1995 road side count are listed in Table 2.

Although not many birds could be found during the first survey, the results were encouraging and one possible study area (Dehiattakandiya) was selected for further research. Preparations for the subsequent year's survey were then made.

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TABLE 1
HISTORICAL RECORDS OF SHAHEEN FALCONS (*FALCO PEREGRINUS PEREGRINATOR*) SEEN OR SHOT IN (CEYLON) SRI LANKA. DATA GATHERED FROM LITERATURE SURVEY AND MUSEUM SKIN EXAMINATION

Date	Location	Description/Observation	Source
1853		Foot of Adams Peak (mistaken for *Falco severus*)	Legge 1878-80
1875	N 08° 46' E 81° 14'	Pigeon Island 14 miles north of Trincomalee, breeding pair, one adult bird shot	Legge 1878-80
1875	N 08° 24' E 80° 30'	Anuradhapura, Tissa Wewa Tank, shot in December	Legge 1878-80
1876	N 07° 06' E 80° 46'	Hewahette, Yakka rock, shot in May	Legge 1878-80
1876	N 06° 48' E 80° 57'	Haputale, shot in August	Legge 1878-80
1876	unknown	Laymaes, juvenile shot in June	Nat. Hist. Museum, Tring
1876	N 07° 18' E 80° 37'	Kandy, one shaheen caught alive	Legge 1878-80
1876	N 07° 17' E 80° 28'	Alagalla Peak, seen in precipices	Legge 1878-80
1878	N 07° 20' E 81° 30'	Friars-Hood District, seen flying	Legge 1878-80
1878	N 06° 57' E 80° 14'	Avisawella, Yakkahatua mountain	
1938	unknown	Kumbalqaumia Hill, juvenile bird shot in December	Nat. Hist. Museum, Tring
1943	N 07° 57' E 80° 45'	Sigiriya, adult bird seen hunting	Wood & Fyfe 1943
1953	N 06° 55' E 81° 10'	Namunukula, Tonacombe Estate, adult male shot in November	Nat. Hist. Museum, Tring
1979	N 08° 26' E 80° 32'	Anuradhapura, observation on a roof in March	Schmidl 1994 pers. comm.
1979	N 07° 55' E 80° 22'	Maho, nesting pair on a rock near railway station - March	Schmidl 1994 pers. comm
1979	N 07° 17' E 81° 32'	Inginiyagala, nesting pair in March	Schmidl 1994 pers. comm.
1979	N 07° 57' E 80° 45'	Sigiriya, breeding pair in March	Schmidl 1994 pers. comm.
1984	N 07° 57' E 80° 45'	Sigiriya, breeding pair in August	Heller M.& I. 1984

In early 1996, a set of data (Lamsfuss 1996a) concerning shaheen sightings in Sri Lanka became available and is listed in Table 4. All data are based on sightings and observations reported in the Ceylon Bird Club Notes (CBCN) for the period 1981 to 1991. Most are single sightings with only very few places where several sightings had been made. One of these is Sigiriya Rock with more than 10 records, another the City of Colombo (Lamsfuss 1996a). From April to May 1996, the second field survey was conducted and was again started with road side counts from Colombo via Ratnapura into the South (Hambantota) and then northwards via Wellawaya-Monaragla-Bibile to Mahiyangana. The data collected during the 1996 road side count are listed in Table 3.

TABLE 2
RESULTS OF 1995 ROAD SIDE COUNTS CARRIED OUT BETWEEN 17.iii.95 AND 29.iii.95

Date	Location	Observations
19.iii.1995	N 06° 31' E 80° 26'	Karawita / Kalawana area, nest site in steep inaccessible cliff, no birds seen.
21.iii.1995	N 07° 37' E 80° 38'	Naula, approx. 10 km south on the Dambulla - Kandy road, one shaheen falcon soaring very high above the rocks.
21.iii.1995	N 07° 57' E 80° 45'	Sigiriya, nest site, but no birds seen.
22.iii.1995	N 07° 57' E 80° 45'	Sigiriya, nest site check, falcon heard but no birds seen.
22.iii.1995	N 07° 40' E 81° 06'	Kudagala Village, a breeding pair in early stage of courtship behaviour.
23.iii.1995	N 07° 40' E 81° 16'	Kudagala - breeding pair courtship behaviour.
23.iii.1995	N 07° 17' E 81° 32'	Inginiyagala, one bird seen flying over the rock.
24.iii.1995	N 07° 19' E 81° 13'	Kehelula, nest site in very steep cliff, one falcon flew across the cliff and entered the nest ledge.

TABLE 3
RESULTS OF THE FIELD SURVEY CONDUCTED FROM APRIL TO MAY, 1996

Date	Location	Description/Observation
09.iv.96	N 06° 31' E 80° 26'	Karawitta/Kalawana, 3 birds observed on nest ledge; 1 adult and 2 fledglings (nest ledge found in 1995).
11.iv.96	N 06° 22' E 81° 14'	Lunuganwehera Reservoir, north of Tissamharama; nest ledge in typical rock outcrop, presence of birds could not be acertained.
12.iv.96	N 06° 41' E 81° 08'	Wellawaya, two adult birds engaged in mating behaviour, but the nest ledge could not be found.
14.iv.96	N 06° 46' E 81° 15'	Buttala; nest ledge in steep rock rafe, one adult bird seen flying around.
15.iv.96	N 06° 55' E 81° 21'	Monaragala, probable nest ledge in rock cliff, but birds could not be observed.
16.iv.96	N 06° 51' E 81° 03'	Ella to Wellawaya, probable nest site in steep rock along the road.
16.iv.96	N 07° 19' E 81° 13'	Kehelula, nest ledge found in previous year, with new white droppings.
17.iv.96	N 07° 40' E 81° 06'	Kudagala rock nest ledge found in previous year, breeding pair present.
19.iv.96	N 07° 51' E 81° 06'	Dimbulagala rock, nest ledge with many white droppings.
20.iv.96	N 06° 48' E 81° 17'	Kumbukkana, nest ledge with typical white droppings.
05.v.96	N 06° 55' E 80° 48'	Hakgala, at 1723 m one shaheen in flight passing by.

RESULTS AND DISCUSSION

The nest sites found in 1995 and nest sites known earlier have allowed a rough calculation of the probable population in Sri Lanka. The mean distances between a cluster of nesting sites (Sigirya, Kudagala, Kehelula, Inginiyagala, Maho) were used for estimating the approximate size of the probable breeding territories. The mean radius was calculated at r = 22.6 km. In this calculation it has to be considered that not every nest site was detected because of the thick forest and long distances from the road; not every potential breeding rock could be reached by car. Furthermore, it was not possible to enter the National Parks by car and in these cases the search was mostly conducted along the borders of the National Parks. A rough estimate of the

TABLE 4
RECORDS COMPILED BY LAMSFUSS (1996A) FROM THE CEYLON BIRD CLUB NOTES, 1981-1995
ONLY THE FIRST DATE OF EACH LOCATION IS GIVEN
(SUBSEQUENT SIGHTINGS AT THE SAME LOCATION ARE NOT LISTED)

Date	Location	Description/Observation
04.xi.80	N 07° 57' E 80° 45'	Sigiriya, no details.
16.ii.81	N 07° 23' E 80° 47'	Kaluphahana Hill, flying, giving warning calls.
21.i.82	N 06° 30' E 81° 35'	Mayagala, a pair sitting in a cave on rock face.
20.ii.83	N 06° 48' E 80° 48'	Horton Plains, World's End, seen from above.
07.i.85	N 06° 50' E 81° 04'	Ravana Ella Falls, seen flying into a rocky ledge.
21.i.86	N 07° 35' E 81° 30'	Heenanigala Rock, no details
25.i.86	N 06° 12' E 81° 15'	Bundala, immatures
07.viii.86	N 07° 00' E 80° 25'	Kitulgala, no details.
iii.87	N 06° 56' E 79° 51'	Colombo, seen hunting and roosting in the centre of the city.
08.ix.89	N 07° 47' E 80° 49'	Bakumana, no details.
28.v.91	N 07° 20' E 80° 45'	Randenigala Reservoir, perched on dead tree close to the water's edge.
21.xii.91	N 06° 26' E 80° 38'	Suriyakanda (SE Rakwana), no details.
11.i.93	N 07° 18' E 80° 38'	Kandy, Mapanawathura Road, adult bird pursued by a flock of crows.
14.iv.93	N 07° 17' E 80° 14'	Ragala Rock, seen on rock cliffs,
27.xii.93	N 07° 52' E 80° 43'	Kandalama, flying overhead.

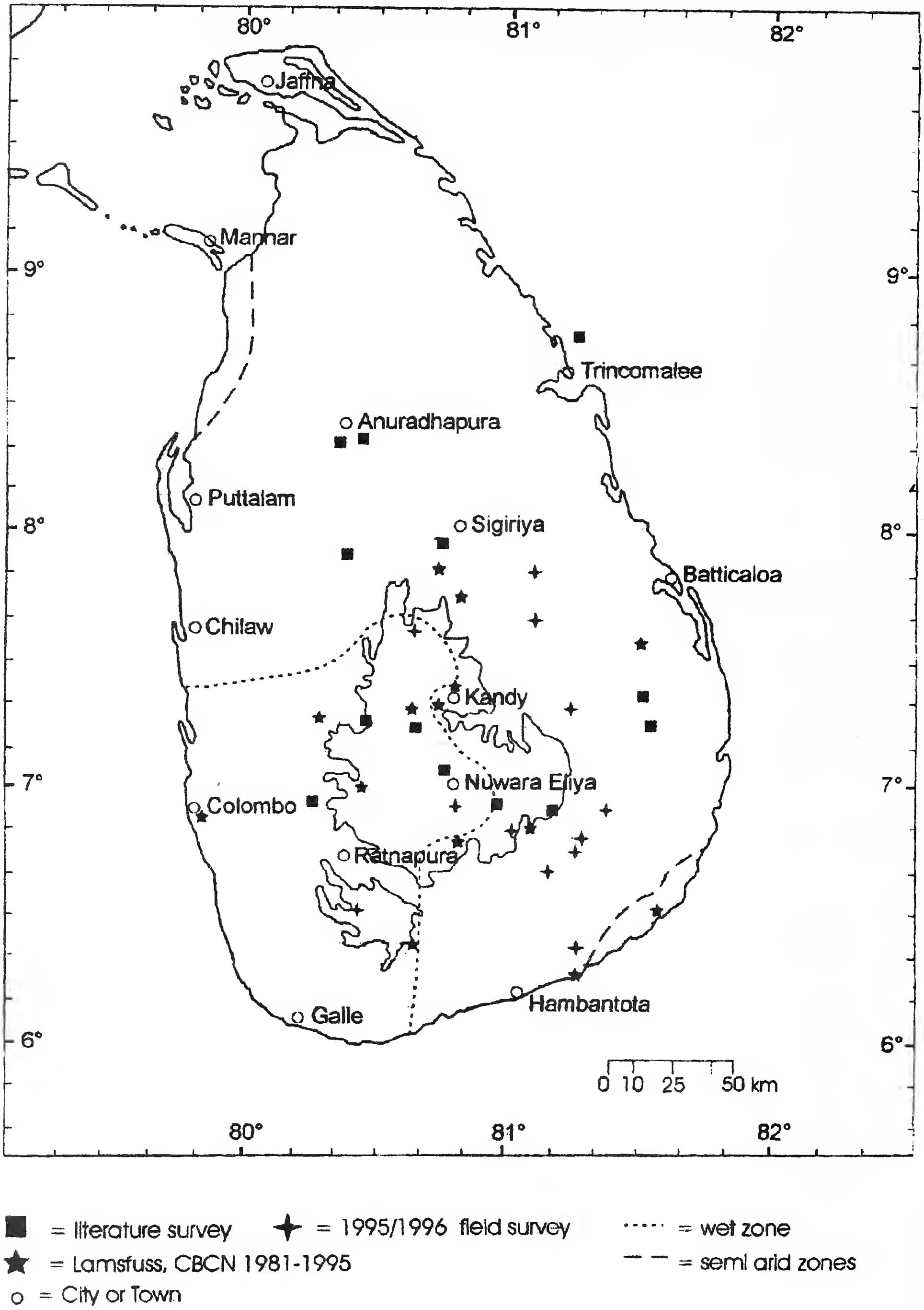

Fig. 1: Map of Sri Lanka showing all locations at which *Falco peregrinus peregrinator* has been recorded (except for the Ceylon Bird Club Notes 1942-1980, which remain to be evaluated).

total population in Sri Lanka is at least 40 breeding pairs of shaheen falcons. Additionally, there would be about 20 birds, the so called non-breeders or surplus birds. It is interesting that this estimate accords well with that of Hoffmann, who suggested approximately 100 individuals.

The findings of 1996 confirmed the original calculation, but new discoveries of nest sites in future would necessitate recalculation. It is assumed that the total number of Shaheen in Sri Lanka would be rather higher. First indications are found in the 1996 results, with the true distance from Wellawaya to Buttala being 17 km, from Buttala to Kumbukkana 4 km and from Kumbukkana to Monaragala 16 km. These distances are much shorter than those found in the previous year, but nest sites need to be confirmed for occupancy during the next survey (Fig. 1). It is still not clear which factors are responsible for limiting the population to this comparatively low number as there were no indications of food shortages or nest site limitations. In Bavaria, a part of southern Germany almost as large as Sri Lanka (65,000 km^2), a breeding population of 115 pairs of peregrine falcon (*Falco peregrinus peregrinus*) has been recorded, and Baden Württemberg has 205 breeding pairs in an area of 35,750 km^2 (Kostrzewa and Speer 1995). The arithmetic mean values are 1 pair for every 1,625 km^2 in Sri Lanka, 1 pair for every 565 km^2 in Bavaria and 1 pair for every 174 km^2 in Baden Württemberg. The very low density of the estimated population in Sri Lanka is obvious. As stated before, neither food shortage nor nest site limitations could be observed, and if it is assumed that the calculated population in Sri Lanka is correct, there must be some other factor(s) responsible for this relatively low density.

Further research and direct field observation will help to provide more details, which promise to be of considerable interest.

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FISH FAUNA, ABUNDANCE AND DISTRIBUTION IN CHALAKUDY RIVER SYSTEM, KERALA[1]

C.R. Ajithkumar[2], K. Rema Devi[3], K. Raju Thomas and C.R. Biju[2]

(*With one text-figure*)

Key words: Freshwater fishes, Chalakudy river, Kerala, Anaimalai hills, Nelliampathy hills, *Barilius bendelisis, Glyptothorax lonah.*

Chalakudy river originating from the Anaimalai and Nelliampathy hill ranges was surveyed from November 1996 to February 1998, and the total number of fish species recorded from this river reached up to ninety-eight. *Glyptothorax lonah* is a new record for Kerala. *Barilius bendelisis* was recorded for the first time from a west flowing river in Kerala. *Hypselobarbus kurali, Puntius dorsalis, Travancoria jonesi, Tetraodon travancoricus, Nemacheilus guentheri, Ompok malabaricus, Euryglossa orientalis* and *Macrospinosa cuja* were reported for the first time from this river. Lowland (<75 m from sea level) and midland (75 to 500 m above msl) have a greater number of species than highland (500 to 750 m above msl) and high ranges (>750 m above msl). This is because of the migratory species recorded in the lowland and midland and also because this area is connected with paddy fields or other wetlands.

Introduction

The Western Ghats are one of the most important biodiversity hot spots in India. In spite of adverse human impacts, they still support a good number of endemic flora and fauna, including fish fauna. Several endemic fish species were recorded from southern Western Ghats (Jayaram 1981; Talwar and Jhingran 1991). Study on fresh water fishes of Kerala started with Day's FISHES OF MALABAR (1865) and FISHES OF INDIA (1889) After that, most of the studies on fishes were conducted in southern Western Ghats i.e. south of Palghat gap during the forties and fifties, and include Pillay (1929), John (1936), Hora and Law (1941), Hora and Nair (1941), Raj (1941), Chacko (1948), Menon (1950) and Silas (1951).

The earliest specific study, in the higher reaches of Chalakudy river system in Anaimalai and Nelliampathy Hills was carried out by Silas (1951). Later, Thobias (1973) did a detailed study of the fishes in Trichur dist. while Antony (1977) studied the hill stream fishes in the same area. Study on the fishes of the lower reaches and the wetlands in Trichur dist. was done by Inasu (1991). From Chalakudy river, Pethiyagoda and Kottelat (1994) have reported three new species, viz, *Osteochilichthys longidorsalis, Travancoria elongata* and *Horabagrus nigricollaris* from Vettilappara, 26 km upstream of Chalakudy town and Shaji *et al.* (1996) have reported a new species *Garra surendranathanii* from Orukomban.

There is, however, no detailed study of the whole Chalakudy river system. We have carried out a detailed survey in the Chalakudy river system including the portions lying in Tamil Nadu State and the results thus obtained were collated with past records to get a clear picture of the present distribution and abundance of fishes.

Study area

River Chalakudy is 144 km long, and its basin lies between latitudes 10° 10' 0" and 10° 33' 30" N and longitude 76° 17' 0" and 77° 4' 0" E.

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It originates from Anaimalai and Nelliampathy hills and joins Periyar river at Elanthikara, a few kilometres before flowing into the sea. The main tributaries of this river are Sholayar, Parambikulam, Kuriarkuty and Karappara. The Sholayar and Parambikulam rivers originate from Anaimalai at 1066 m and 1676 m above msl respectively. Sholayar flows westwards for 44.8 km and then turns northwards and joins Parambikulam river, 1.6 km before Orukombankutty at an elevation of 473 m. Parambikulam river flows parallel and north to Sholayar. Kuriarkuty river also originates from the Anaimalai hills and joins Parambikulam river. Karapara river originates from the Nelliampathy hills of Palakkad dist. at an elevation of 914 m, flows west and turns southwest till it joins Parambikulam river at Orukombankutty; from this point the river is known as Chalakudy river. Before its confluence with Periyar there are some smaller streams such as Charppa thodu, Kannamkuzhi, Pillaparathodu and Arurmuzhi. Till it reaches the plains, the river has a rocky bottom with deep crevices and pools, rapids and falls, a famous one being Athirapilly falls.

Chalakudy river has a catchment area of 1,704 sq. km and the total runoff is 3,121 x 10^6 m^3. There are a number of reservoirs in the river system, viz. Parambikulam, Thunakadavu, Peruvaripallam, Malakkapara, lower Sholayar, and Poringalkuthu.

Method

During 1996-97 the survey was carried out in Nelliampathy, Anaimalai and Cardamom hills (south of the Palghat gap). This includes Parambikulam Wildlife Sanctuary and part of Indira Gandhi Wildlife Sanctuary. Post-monsoon period was suitable for fish survey. 1:50,000 Survey of India topo sheets were used to pinpoint the approachable sites and to identify the stream order. At the sampling site, careful observation was made without disturbing the water and visual count for roughly 2 sq. m area was carried out if the water was clear. In the post-monsoon period, the water was rarely turbid. Various sampling methods such as cast net, scoop net, gill net and a circular net with very small mesh and sinkers on the edge, were used to catch different species, adding to the visual count. A constant number of efforts was made to reduce statistical bias. Samples were preserved in 10% formalin and kept for identification and further studies. Fishes were identified mainly from Jayaram (1981) and Talwar and Jhingran (1991).

Based on altitude, the study area was classified into four main divisions; (1) Lowland (<75 m from sea level), (2) Midland (75 to 500 m above msl), (3) Highland (500 to 750 m above msl), (4) High ranges (>750 m above msl) Distributional variation and seasonal abundance of the species were closely observed.

Results and Discussions

As the western side of the Western Ghats is narrow, the rivers flowing westward are also smaller than the east flowing rivers. Moreover, in these river systems, separated as they are from each other by hills, easy mixing of species is difficult. Though these rivers are small in size, the number of fish species is high. Chalakudy river is one of the important rivers in Kerala with highly diverse fish fauna.

Fish Fauna

During the present survey, 83 species were recorded. A complete list of fish from this river, including past records, gives a total number of 98 species, 34 families and 10 orders. Previous records that have been included in this list are of Silas (1951); Thobias (1972); Antony (1977); Inasu (1991); Pethiyagoda and Kottelat (1994) and Biju *et al.* (1998, 1999). The most abundant order in this report is Cypriniformes followed by Perciformes and Siluriformes. The family with the maximum number of representatives is Cyprinidae. The most abundant genus in this

river is *Puntius* followed by *Mystus*. This list includes typical primary freshwater fishes, secondary freshwater fishes or migratory fishes and wetland species.

Silas (1951) studied the Ponnani drainage and Periyar drainage system (he considered Chalakudy river as a part of Periyar because it is connected with Periyar just before it joins the Arabian Sea). He recorded eight species from Nelliampathy hills. The works of Thobias (1973), Antony (1977) and Inasu (1991) were concentrated only in the Thrissur (= Trichur) dist. Hence their list of species also included fishes from Karuvannur and Kecheri rivers. Thobias (1973) collected 58 species of freshwater fishes from Thrissur dist. of which 51 were found in the Chalakudy river. Antony (1977) described 48 species of hill stream fishes from Thrissur district, of which 42 species were from Chalakudy river. Inasu (1991) studied the distribution of inland fishes and listed 57 species, of which 17 species were from the Chalakudy river. Pethiyagoda and Kottelat (1994) have reported three new species from this river under the genera *Travancoria, Osteochilichthys* and *Horabagrus.* Shaji *et al.* (1996) reported a new species under the genus *Garra.* Biju *et al.* (1999) reported 40 species of freshwater fishes of Parambikulam Wildlife Sanctuary. 15 species that have been recorded by previous workers were not located by us during the present survey.

Hypselobarbus kurali, *Puntius dorsalis*, *Travancoria jonesi*, *Macrospinosa cuja*, *Euryglossa orientalis*, *Nemacheilus guentheri*, *Ompok malabaricus* and *Tetraodon travancoricus* are reported for the first time from this river.

Tor khudree is considered as a rare and endangered species in Kerala. This species was recorded in good numbers from upstream stretches. Moreover, one specimen of this species was collected from the lowlying Kanakkankadavu area. *Tor khudree* is a sport fish, and specialised methods to catch fish in the river have resulted in this species being endangered and listed accordingly. One specimen recorded from Kanakkankadavu showed it can thrive in lowland, midland and highland streams.

The fishes recorded from the present survey and the past records (*) are given in Table 1. The fishes are classified according to Talwar and Jhingran (1991) with modifications from Menon (in press).

Notes on some interesting species

1. ***Garra surendranathanii*** Shaji *et al.* 1996. *Garra surendranathanii* Shaji *et al.*, JBNHS, 93(3): 572-575

13 specimens of *G. surendranathanii* were collected from Orukombankutty and nearby places. This species described by Shaji *et al.* from Chalakudy, Periyar and Pamba rivers of Kerala,

TABLE 1

LIST OF SPECIES RECORDED FROM CHALAKUDY RIVER

Sp. No.		
	I	Order: Elopiformes Family: Megalopidae
1.	*Megalops cyprinoides* (Broussonet)	
	II	Order: Anguilliformes Family: Anguillidae
2.	*Anguilla bengalensis bengalensis* (Gray & Hardwicke)	
3.	*Anguilla bicolor bicolor* McClelland	
	III	Order: Clupeiformes Family: Clupeidae Subfamily: Pellonulinae
4.	*Dayella malabarica* (Day)	
		Family: Engraulididae
5.	*Stolephorus commersonii* Lacepede	
	IV	Order: Cypriniformes Family: Cyprinidae Subfamily: Cyprininae
6.	*Catla catla* (Hamilton)	
7.	*Cirrhinus mrigala* (Hamilton)	
8.	*Cyprinus carpio communis* Linnaeus	
9.	*Hypselobarbus curmuca* (Hamilton)	
10.	*H. kolus* (Sykes)	

TABLE 1 (*contd.*)
LIST OF SPECIES RECORDED FROM CHALAKUDY RIVER

Sp. No.	
11.	*H. thomassi* Day*
12.	*Hypselobarbus jerdoni* (Day)
13.	*H. micropogon* (Val.)*
14.	*H. pulchellus* Day*
15.	*H. kurali* Menon & Rema Devi
16.	*Labeo rohita* (Hamilton)
17.	*L. calbasu* (Hamilton)*
18.	*Osteobrama bakeri* (Day)
19.	*Osteochilichthys longidorsalis* Pethiyagoda and Kottelat
20.	*O. thomassi* (Day)*
21.	*Puntius amphibius* (Valenciennes)
22.	*P. chola* (Hamilton)
23.	*P. denisonii* (Day)
24.	*P. dorsalis* (Jerdon)
25.	*P. filamentosus* (Valenciennes)
26.	*P. melanostigma* (Day)*
27.	*P. melanampyx* (Day)
28.	*P. parrah* Day
29.	*P. ticto* (Hamilton)
30.	*P. vittatus* Day
31.	*Barbodes carnaticus* (Jerdon)
32.	*Barbodes sarana subnasutus* (Valenciennes)
33.	*Tor khudree* (Sykes)
	Subfamily: Cultrinae
34.	*Salmostoma boopis* (Day)
	Subfamily: Rasborinae
35.	*Amblypharyngodon melettinus* (Valenciennes)
36.	*Barilius bakeri* Day
37.	*B. bendelisis* (Hamilton)
38.	*B. gatensis* (Valenciennes)
39.	*Danio aequipinnatus* (McClelland)
40.	*D. malabaricus* (Jerdon)
41.	*Esomus danricus* (Hamilton)
42.	*Parluciosoma daniconius* (Hamilton)
	Subfamily: Garrinae
43.	*Garra lamta* (Hamilton)*
44.	*G. mcClellandi* Jerdon*
45.	*G. mullya* (Sykes)
46.	*G. surendranathanii* Shaji, Arun & Easa
	Family: Balitoridae
	Subfamily: Balitorinae
47.	*Bhavania australis* (Jerdon)
48.	*Travancoria elongata* Pethiyagoda & Kottelat*
49.	*Travancoria jonesi* Hora
	Subfamily: Nemacheilinae
50.	*Nemacheilus guentheri* Day
51.	*N. triangularis* Day
	Family: Cobitidae
	Subfamily: Cobitinae
52.	*Lepidocephalus thermalis* (Valenciennes)
	V Order: Siluriformes
	Family: Bagridae
53.	*Horabagrus brachysoma* (Gunther)
54.	*H. nigricollaris* Pethiyagoda &Kottelat*
55.	*Pseudobagrus chryseus* (Day)*
56.	*Mystus gulio* (Hamilton)
57.	*M. armatus* (Day)
58.	*M. cavasius* (Hamilton)
59.	*M. malabaricus* (Jerdon)
60.	*M. oculatus* (Valenciennes)
61.	*M. vittatus* (Bloch)*
	Family: Siluridae
62.	*Ompok bimaculatus* (Bloch)
63.	*O. malabaricus* (Valenciennes)
64.	*Wallago attu* (Schneider)
	Family: Sisoridae
65.	*Glyptothorax lonah* (Sykes)
66.	*Glyptothorax madraspatanum* Day*
	Family: Claridae
67.	*Clarias batrachus* (Linnaeus)
	Family: Heteropneustidae
68.	*Heteropneustes fossilis* (Bloch)
	Family: Ariidae
69.	*Arius caelatus* Valenciennes
	VI Order: Cyprinodontiformes
	Family: Hemirhamphidae
70.	*Hyporhamphus limbatus* (Valenciennes)
	Family: Belonidae
71.	*Xenentodon cancila* (Hamilton)
	Family: Aplocheilidae
72.	*Aplocheilus lineatus* (Valenciennes)
73.	*Aplocheilus panchax* (Hamilton)*
	VII Order: Synbranchiformes
	Family: Synbranchidae
74.	*Ophisternon bengalense* McClelland*
	VIII Order: Perciformes
	Family: Ambassidae
75.	*Parambassis thomassi* (Day)
76.	*Parambassis dayi* (Bleeker)
	Family: Teraponidae
77.	*Terapon jarbua* (Forsskal)
	Family: Carangidae
78.	*Caranx carangus* (Bloch)
	Family: Lutjanidae
79.	*Lutjanus argentimaculatus* (Forsskal)

TABLE 1 (*contd.*)
LIST OF SPECIES RECORDED FROM CHALAKUDY RIVER

Sp. No.		Sp. No.	
	Family: Gerreidae		Family: Anabantidae
80.	*Gerres filamentosus* Cuvier	90.	*Anabas testudineus* (Bloch)
	Family: Sciaenidae		Family: Belontidae
81.	*Macrospinosa cuja* (Hamilton)		Subfamily: Macropodinae
	Family: Scatophagidae	91.	*Macropodus cupanus* (Valenciennes)
82.	*Scatophagus argus* (Linnaeus)		Family: Channidae
	Family: Nandidae	92.	*Channa marulius*
	Subfamily: Pristolepidinae		(Hamilton-Buchanan)
83.	*Pristolepis marginatus* Jerdon	93.	*C. orientalis* Bloch and Schneider
	Subfamily: Nandinae	94.	*C. striatus* (Bloch)
84.	*Nandus nandus* (Hamilton)		Family: Mastacembelidae
	Family: Cichlidae	95.	*Macrognathus guentheri* (Day)
85.	*Etroplus maculatus* (Bloch)	96.	*Mastacembelus armatus* (Lecepede)
86.	*E. suratensis* (Bloch)		IX Order: Pleuronectiformes
87.	*Oreochromis mossambica* (Peters)		Family: Solteidae
	Family: Mugilidae	97.	*Euryglossa orientalis* (Bloch & Schneider)
88.	*Mugil cephalus* Linnaeus		X Order: Tetraodontiformes
	Family: Gobiidae		Family: Tetraodontidae
	Subfamily: Gobinae		
89.	*Glossogobius giuris* (Hamilton)	98.	*Tetraodon travancoricus* Hora & Nair

*Recorded by previous workers

shows great resemblance to *G. mcClellandi* (Jerdon) in body form, position of the dorsal fin and number of lateral line scales. But it can be distinguished by the nature of spine in the tubercles. *G. mullya* and *G. menoni* differ from it in the number of lateral line scales. It differs from *G. hughi* (Silas) by the presence of scales in the mid-dorsal streak and from *G. gotyla stenorhyncus* (Jerdon) in the absence of a proboscis. This survey confirmed the presence of this species only in its type locality, Orukombankutty. This is the sixth type of species under the genus *Garra,* recorded from Kerala.

2. ***Osteochilichthys longidorsalis*** Pethiyagoda & Kottelat

1994. *Osteochilichthys longidorsalis,* Pethiyagoda & Kottelat, *J. South Asian nat. Hist.,* 1(1): 97-116

The first report of this species was from Chalakudy river, near Vettilappara (type locality), 26 km upstream of Chalakudy town. During the present survey, one specimen of this species was collected from the Parambikulam river, tributary of Chalakudy river, two kilometres away from Orukombankutty. This species has distinctive characters from all other species of the genus in having 10 branched rays and a markedly elongate last simple dorsal fin ray. It differs from *O. thomassi* in the absence of a dark lateral stripe, by having a shallower body, and not having a fimbriated upper lip. It can be distinguished from *O. nashii* by having a shallower body and by the absence of a dark blotch on the dorsal fin. The present report of this species is the second one from Kerala from the same river.

3. ***Barilius bendelisis*** (Hamilton)

B. bendelisis (Ham.) is one of the principal hillstream fish in the rivers of Jammu. It is characterised by eight to twelve dark bands descending towards the lateral line which become indistinct as spots in adults and lateral line scales with two black spots at their base. It was considered to be present throughout India except Kerala (Talwar and Jhingran 1991). It was reported from Periyar lake, Thekkady by Chacko (1948), but later Jayaram (1981), Talwar and

Jhingran (1991) considered this as erroneous. Easa and Shaji (1996) have reported this species from the east flowing Pambar river, Chinnar Wildlife Sanctuary, Kerala. This report confirmed its occurrence in Kerala.

During the present survey six specimens of this species were collected from Thekkadiar tributary of Chalakudy river in Parambikulam Wildlife Sanctuary area. This is the first report of this species from a west flowing river in Kerala (Raju Thomas *et al.* 1998).

4. ***Glyptothorax lonah*** (Sykes)

Six specimens of *G. lonah* were collected from Karappara river in Parambikulam Wildlife Sanctuary area and also from Nelliampathy area. The known distribution of this species was Deccan plateau, Godavari and Krishna river systems. Silas (1951) extended its distribution to the headwaters of Cauvery river. It was first reported from Kerala by Biju *et al.* 1998). A small description of this species is given below:

Body elongate, head depressed, as long as broad; occipital process about 4 times as long as broad, apposed to basal bone of dorsal fin. Maxillary barbels extend posteriorly to anterior third of pectoral fins. Adhesive apparatus longer than broad, without a central pit. Dorsal fin inserted nearer to adipose fin than to snout tip.

5. ***Horabagrus nigricollaris***
Pethiyagoda & Kottelat

Type locality of this species is Chalakudy river, 26 km upstream of Chalakudy town, near Vettilappara. It is distinguished from *H. brachysoma* by the colour pattern; it has a black saddle shaped bar extending across the dorsum from the humeral region of each side; and also by having a shorter head, a larger eye, a broader pectoral girdle, a longer dorsal spine and a smaller distance between the dorsal origin and coracoid. The two species also differ in the shape of the adipose fin, in *H. nigricollaris,* the dorsal profile of the adipose fin is continuous with the dorsal profile of the dorsum anterior to it. During the present study, this fish has not been located anywhere in this river.

6. ***Travancoria elongata***
Pethiyagoda & Kottelat

This species was also described from the Chalakudy river near Vettilappara. It is distinguished from its only congener in having a more slender body, a longer and more slender caudal peduncle, and lobes of the rostral cap between the rostral barbels present, but not developed into barbel-like projections. During the present study, it has not been located in this river.

7. ***Tetraodon travancoricus***
Hora and Nair

This is a small species, less than an inch in length. Hora and Nair (1941) described this fish from Pambar river, Kerala. In the present survey, 75 specimens of this fish were collected from Kanakkankadavu area, Ernakulam district. This is the first report of this species from this river.

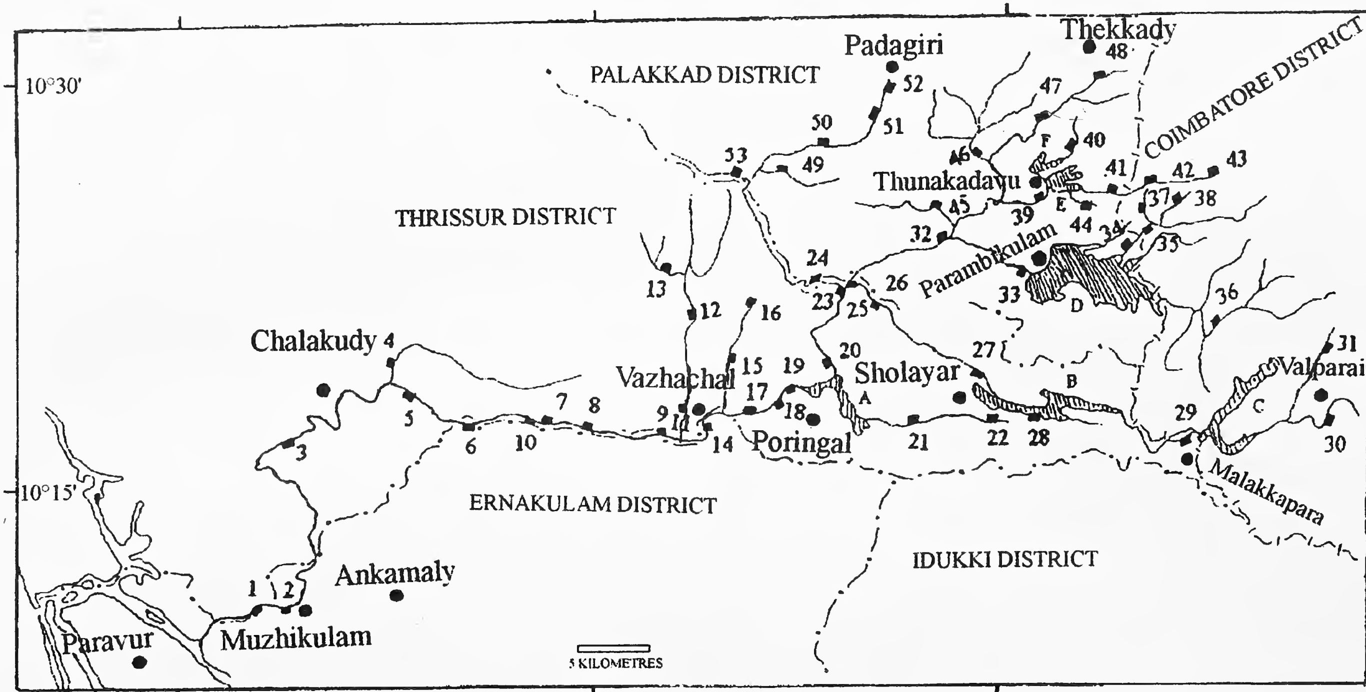
Distribution and abundance of fishes

Samples were collected from 53 locations (Fig. 1), mainly in two seasons, viz, summer and post-monsoon periods. Separate collections were taken from lowland, midland, highland and high range areas. Distribution of various species under each altitudinal area is given in Table 2.

A total of 61 species were recorded from lowland areas, out of which 26 were specific to this zone. In this survey, 12 species of migratory or secondary freshwater fishes were obtained (Table 3). Most of the migratory or secondary freshwater fishes were restricted to the lowland area except *Megalopes cyprinoides* and *Euryglossa orientalis,* which were reported even 50 km away from the sea coast in the midland area.

Macrospinosa cuja is the first report from the freshwaters of Kerala. It was reported primarily from the Gangetic estuary. Hence its record from Kerala is interesting. The presence of this species in this river may be due to its introduction, considering its commercial value.

Fig.1: Map of Chalakudy river showing various collection sites and reservoirs



Collection sites

1. Kanakkankadavu	11. Kannamkuzhi	21. Anakayam	31. Valparai-a	41. Anappady	51. Karappara-a
2. Muzhikulam	12. Kannamkuzhi-a	22. Anakayam-a	32. Kuriarkutty	42. Kozhikamathy	52. Nelliampathy
3. Kadukutty	13. Kannamkuzhi-b	23. Karaparakutty	33. Parambikulam	43. Kozhikamathy-a	53. Pullaikkal
4. Pariyaram	14. Athirapilly	24. Karaparakutty-a	34. Varakiliyar	44. Sichali thodu	**Reservoirs**
5. Pulani	15. Charpa	25. Orukombankutty	35. Varakiliyar-a	45. Pulikal	A. Poringalkuthu
6. Adichily	16. Charpa-a	26. Orukomban	36. Panathiar	46. Vetiar	B. Sholayar
7. Arurmuzhi	17. Vazhachal	27. Sholayar	37. Meenmettupallam	47. Thekkady	C. Malakkapara
8. Vettilapara	18. Puliyilapara	28. Ambalapara	38. Koorampalliyar	48. Thekkady-a	D. Parambikulam
9. Pillapara	19. Poringal	29. Malakkapara	39. Thunakadavu	49. Chakkali	E. Thunakadavu
10. Ezhattumugam	20. Poringal-a	30. Valparai	40. Sungam	50. Karappara	F. Peruvaripallam

TABLE 2
DISTRIBUTION AND STATUS OF FISHES IN DIFFERENT ALTITUDINAL ZONES IN CHALAKUDY RIVER SYSTEM

No.	Species	#1	#2	#3	#4	Status	GT
1.	*Stolephorus commersonii*	+				Migratory	
2.	*Anguilla bicolor bicolor*	+				Rare	
3.	*Hypselobarbus kurali*	+				Rare	
4.	*Puntius denisoni*	+				Rare	
5.	*Tetraodon travancoricus*	+				Rare	
6.	*Horabagrus brachysoma*	+				Common	
7.	*Mystus gulio*	+				Migratory	
8.	*Mystus cavasius*	+				Common	
9.	*Heteropneustes fossilis*	+				Rare	
10.	*Arius caelatus*	+				Migratory	
11.	*Hyporhamphus limbatus*	+				Common	
12.	*Wallago attu*	+				Rare	
13.	*Labeo calbasu**,***	-				Not found	
14.	*Terapon jarbua*	+				Migratory	
15.	*Caranx carangus*	+				Migratory	
16.	*Lutjanus argentimaculatus*	+				Migratory	
17.	*Gerres filamentosus*	+				Migratory	
18.	*Macrospinosa cuja*	+				Migratory	
19.	*Scatophagus argus*	+				Migratory	
20.	*Nandus nandus*	+				Rare	
21.	*Mugil cephalus*	+				Migratory	
22.	*Macropodus cupanus*	+				Common	
23.	*Aplocheilus panchax****	-				Not found	
24.	*Pseudobagrus chryseus**	-				Not found	
25.	*Puntius melanostigma****	-				Not found	
26.	*Parambassis dayi*	+				Common	26
27.	*Anguilla bengalensis bengalensis*	+	+			Common	
28.	*Megalops cyprinoides*	+	+			Migratory	
29.	*Dayella malabarica*	+	+			Common	
30.	*Hypselobarbus jerdoni*	+	+			Common	
31.	*Puntius ticto*	+	+			Very Common	
32.	*Puntius vittatus*	+	+			Very Common	
33.	*Channa orientalis*	+	+			Common	
34.	*Channa striatus*	+	+			Common	
35.	*Barbodes sarana subnasutus*	+	+			Very Common	
36.	*Osteobrama bakeri*	+	+			Common	
37.	*Clarias batrachus*	+	+			Common	
38.	*Mystus oculatus*	+	+			Common	
39.	*Xenentodon cancila*	+	+			Common	
40.	*Mastacembelus armatus*	+	+			Common	
41.	*Euryglossa orientalis*	+	+			Migratory	
42.	*Parambassis thomassi*	+	+			Common	
43.	*Glossogobius giuris*	+	+			Common	
44.	*Anabas testudineus*	+	+			Common	
45.	*Hypselobarbus pulchellus****, **	-	-			Not found	19
46.	*Salmostoma boopis*		+			Common	
47.	*Amblypharyngodon melettinus*		+			Common	
48.	*Garra surendranathanii*		+			Rare	
49.	*Cyprinus carpio communis*		+			Introduced	
50.	*Puntius chola*		+			Common	
51.	*Osteochilichthys longidorsalis*		+			Rare	
52.	*Puntius parrah*		+			Common	

TABLE 2

DISTRIBUTION AND STATUS OF FISHES IN DIFFERENT ALTITUDINAL ZONES IN CHALAKUDY RIVER SYSTEM

No.	Species	#1	#2	#3	#4	Status	GT
53.	*Hypselobarbus kolus*		+			Very rare	
54.	*H. micropogon***		-			Not found	
55.	*H. thomassi**		-			Not found	
56.	*Osteochilichthys thomassi***		-			Not found	
57.	*Garra lamta**		-			Not found	
58.	*G. mcClellandi***		-			Not found	
59.	*Horabagrus nigricollaris*****		-			Not found	
60.	*Travancoria elongata*****		-			Not found	
61.	*Mystus vittatus***		-			Not found	
62.	*Ophisternon benglense**		-			Not found	17
63.	*Barbodes carnaticus*		+	+		Rare	
64.	*Puntius dorsalis*		+	+		Common	
65.	*Catla catla*		+	+		Introduced	
66.	*Cirrhinus mrigala*		+	+		Introduced	
67.	*Labeo rohita*		+	+		Introduced	
68.	*Hypselobarbus curmuca*		+	+		Rare	
69.	*Barilius bakeri*		+	+		Common	
70.	*Esomus danricus*		+	+		Rare	
71.	*Bhavania australis*		+	+		Rare	
72.	*Mystus malabaricus*		+	+		Common	
73.	*Pristolepis marginata*		+	+		Common	
74.	*Macrognathus guentheri*		+	+		Common	
75.	*Glyptothorax madraspatanum**,**		-	-		Not found	13
76.	*Mystus armatus*	+	+	+	+	Very common	
77.	*Puntius amphibius*	+	+	+	+	Very common	
78.	*P. filamentosus*	+	+	+	+	Very common	
79.	*P. melanampyx*	+	+	+	+	Very common	
80.	*Danio aequipinnatus*	+	+	+	+	Very common	
81.	*Danio malabaricus*	+	+	+	+	Very common	
82.	*Parluciosoma daniconius*	+	+	+	+	Very common	
83.	*Garra mullya*	+	+	+	+	Very common	
84.	*Nemacheilus triangularis*	+	+	+	+	Common	
85.	*Etroplus maculatus*	+	+	+	+	Very common	
86.	*Oreochromis mossambica*	+	+	+	+	Introduced and very common	11
87.	*Aplocheilus lineatus*	+	+	+		Very common	
88.	*Etroplus suratensis*	+	+	+		Common	
89.	*Channa marulius*	+	+	+		Common	
90.	*Lepidocephalus thermalis*	+	+	+		Very common	
91.	*Tor khudree*	+	+	+		Rare	5
92.	*Ompok bimaculatus*	+		+		Common	
93.	*Barilius gatensis*		+	+	+	Common	
94.	*Nemacheilus guentheri*		+	+	+	Common	
95.	*Barilius bendelisis*			+		Rare	
96.	*Ompok malabaricus*			+		Common	
97.	*Travancoria jonesi*			+		Very rare	
98.	*Glypotothorax lonah*			+	+	Very rare	7
	Total	61	68	36	14		

* Thobias, 1973; ** Antony, 1977; ***Inasu, 1991; **** Pethiyagoda & Kottelat, 1994

Species recorded in various altitude zones

1. <75 m above msl #2. 76-500m above msl #3. 501-750m above msl #4. >750m above msl; GT -Group Total

TABLE 3
SECONDARY FRESHWATER FISH DISTRIBUTION IN THE CHALAKUDY RIVER

Species	Nature of Species	#1	#2	#3	#4	Abundance
Stolephorus commersonii	Coastal pelagic	+				Common
Mystus gulio	Estuarine	+				Common
Arius caelatus	Estuarine	+				Rare
Terapon jarbua	Coastal	+				Common
Caranx carangus	Marine	+				Rare
Lutjanus argentimaculatus	Estuarine	+				Rare
Gerres filamentosus	Coastal	+				Rare
Macrospinosa cuja	Estuarine	+				Very rare
Scatophagus argus	Estuarine	+				Rare
Mugil cephalus	Estuarine	+				Common
Euryglossa orientalis	Coastal	+	+			Rare
Megalops cyprinoides	Coastal pelagic	+	+			Common

Species recorded in various altitude zones
#1. <75 m above msl; #2. 76-500 m above msl; #3. 501-750 msl; #4. >750 m above msl

Highest number of species (68) was recorded from midland, whereas the least number of species (14) from the high ranges. In the lowland and midland areas freshwater fish diversity was very high. This may be due to the presence of migratory fishes and the deep waterbodies sufficient for the fish life in these areas in all seasons. Moreover, the paddy fields or the wetlands are also connected with the lowlands. Besides these, during the summer months fishes from upstream migràted towards the lower reaches and midland areas.

19 species were found both in the lowland and midland areas, whereas 17 species were found only in the midland area, out of which 9 previously recorded species were not located during the present study. 13 species were collected from both the midland and highland areas.

Of the total fishes obtained, 15 species were found to be very common, out of which 11 had a uniform distribution throughout the river system. 34 species were common while 15 were rare. Six species were considered very rare, namely *Hypselobarbus thomassi, Labeo calbasu, Glyptothorax madraspatanm* (past records), *Hypselobarbus kolus, Glyptothorax lonah* and *Travancoria jonesi.* Five species from those collected were introduced species. Among the introduced species *Oreochromis mossambica* was one of the well established fishes and it was recorded from all the four zones. Though *Garra mullya* is modified to survive in the hill streams, this species was found seasonally in various zones. *G. lonah, T. jonesi, Ompok malabaricus* and *Barilius bendelisis* were restricted to highland or high ranges.

During the present survey, we were not able to collect 15 species that were recorded by earlier workers and are marked with asterisk in Tables 1 & 2. Of these 15 species, *Labeo calbasu* can be considered as locally endangered. *Hypselobarbus kolus* is being considered as a synonym of *Hypselobarbus curmuca* (Menon, in press).

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BIONOMICS AND BIOCONTROL EFFICIENCY OF *ANASTATUS* SP. (EUPELMIDAE: HYMENOPTERA), AN EGG PARASITE OF *CHORISONEURA BILIGATA* (SERVILLE) (BLATTELLIDAE: DICTYOPTERA)[1]

S. Bhoopathy[2]

(With nine text-figures)

Key words: Egg parasites, cockroach, bionomics, biocontrol, *Chorisoneura biligata, Anastatus* sp.

In the course of this study, it was found that the ootheca of the cockroach *Chorisoneura biligata* (Serville) was parasitized by an eupelmid species, *Anastatus* sp. which shows morphological resemblance to *Anastatus tenuipes* in many respects, but differs in the general coloration, size and in the tips of male antennae. The duration of its life cycle was between 26 and 35 days. Although absolute host specificity was not found, a single female by ovipositing in 3 oothecae contributes to the control of 36 - 54 host eggs.

Introduction

Insect parasites of cockroaches have attracted the attention of many investigators. Roth and Willis (1954a, 1954b) have given details of distribution, development, behaviour and sex ratios of several entomophagous parasitoids belonging to orders Hymenoptera, Diptera, and Coleoptera which infest cockroaches. The biology of the encyrtid parasite, *Camperia merceti,* developing in the eggs of *Blattella germanica* and *Supella longipalpa* had been thoroughly investigated by Lawson (1954) and Zimmerman (1944). The genus *Anastatus,* family Eupelmidae, is known to parasitize the eggs of several species of cockroaches. *Anastatus floridanus* has been recorded from the oothecae of *Blatta orientalis, Periplaneta americana* and *Eurycotis floridanus,* the last named species being the natural host for that eupelmid parasite (Roth and Willis 1954a). Flock (1941) studied the development, rate of parasitization and sex ratio of *Anastatus tenuipes.* The biology of *Anastatus* sp. parasitic on the eggs of *S. longipalpa* was studied by Ananthasubramanian and Ananthakrishnan (1961). Uma *et al.* (1982 a,b) studied the biology of *Anastatus umae* parasitic on the eggs of *Neostylopyga rhombifolia.* In the family Eulophidae *Tetrastichus hangenowii* was found to parasitize the eggs of several species of cockroaches such as *Periplaneta americana, Blattella germanica* and *Blatta orientalis* (Takahashi 1924, Sonan 1924, Bodenheimer 1930, Rau 1940, Usman 1949, Roth and Willis 1954a). Schal *et al.* (1984) studied the interspecific associations of cockroaches. Bhoopathy (1995) studied the bionomics of the evaniid parasite *Brachygaster minutus* (Oliver), parasitic on the eggs of the cockroach *Blattella humbertiana* Saussure. The parasites such as nematodes and protozoans were also found in the intestines of cockroaches (Bhoopathy 1996). A number of parasites and predators were listed by Bhoopathy (1986) in some cockroach species.

Bionomics and life history of hymenopteran parasitoids were studied by Nikam *et al* (1987). Baktharatchagan (1993) and Panicker and Srinivasan (1992) worked out the biology of *Anastatus tenuipes* parasitic on the brown banded cockroach *Supella longipalpa.* Uma (1992) did comparative biological studies on the two oothecal parasitoids *Comperia merceti* and

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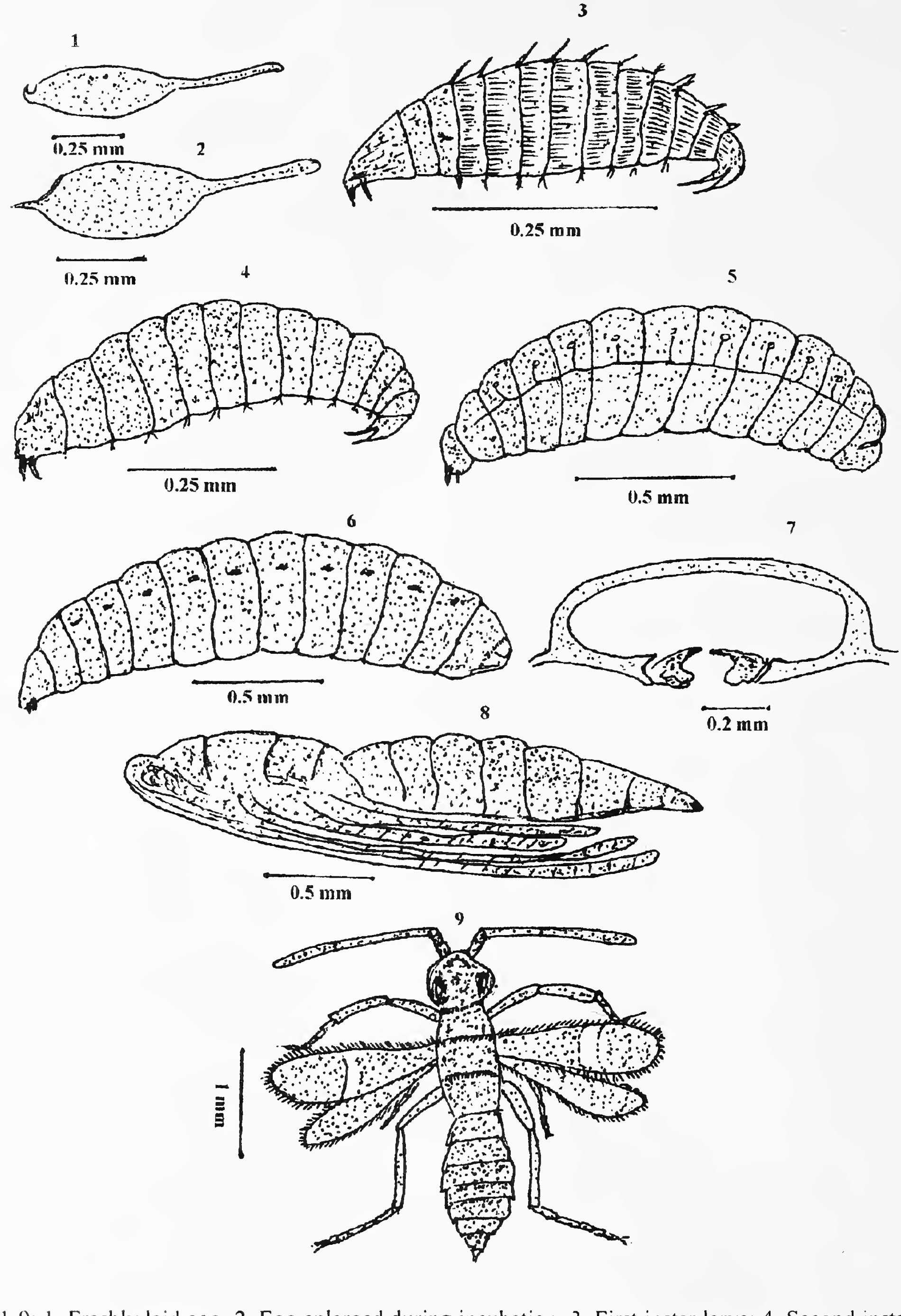

Figs. 1-9: 1. Freshly laid egg; 2. Egg enlarged during incubation; 3. First instar larva; 4. Second instar larva; 5. Third instar larva; 6. Mature larva; 7. Mandibles of mature larva; 8. Pupa; 9. Adult female.

Anastatus tenuipes. The reproductive strategies of the egg parasitoid *Trissolcus* sp. was studied by Senrayan *et al.* (1988). The efficiency of parasites and their development in relation to the age of the host was studied by Kumarasingha and Jayanthi (1987), on oothecal parasites of *Periplaneta americana*.

However, no information was available on *Anastatus* sp. except for the two references mentioned above. In the present study, the bionomics of *Anastatus* sp. parasitic on *Chorisoneura biligata* and its biological control efficiency were investigated.

Material and Methods

Oothecae of *C. biligata* glued on the host plants were collected and reared individually in test tubes measuring 10 x 1.5 cm, plugged with cotton wool. The parasites could be seen when the oothecae were held against light, especially in the later stages of parasite development. When the adult parasites emerged from the oothecae, they were fed on droplets of honey and kept alive. Freshly deposited oothecae of *C. biligata* were exposed to *Anastatus* sp. for parasitization, to study the host hunting and ovipositing behaviour of the parasite. Parasitized oothecae were reared in test tubes, and a few of them were dissected in normal saline at intervals of 24 hours to study the parasitoid eggs, larval and pupal stages. The eggs and immature stages of the parasite were mounted in glycerine to study their structure.

To determine the efficiency of biological control by the egg parasite, enough oothecae were offered for oviposition and the number of adults finally emerging from them were counted. Unmated females of *Anastatus* sp. were offered host eggs, to find out whether parthenogenesis occurred and the fate of offspring resulting from that phenomenon. Adult parasites were reared by feeding them honey solution, prepared by dissolving one part of honey in 5 parts of water, in order to observe the behaviour of the adults, longevity, fecundity and mating behaviour.

Results

Bionomics of *Anastatus* sp., parasitic on the egg of *Chorisoneura biligata*.

Immature stages

Egg: Nearly cylindrical, oblong, stalked, stalk nearly as long as egg and club-shaped; a short, slender, recurved flagellum at the opposite end of egg; the flagellum straightens when the egg swells up after it is inserted into the ootheca. Ovarian egg black, the hue fading to translucent after being deposited into ootheca. Length of egg 0.65 mm, including stalk; stalk 0.3 mm long; flagellum 0.4 mm; egg swelling up about 3.5 times its size within an hour after deposition.

Dissections on ootheca of *C. biligata* egg-capsules soon after parasitization by *Anastatus* sp., revealed 25-45 eggs of the parasite per oötheca. The duration of egg stage was found to be 2-3 days. Five to nine eggs of the parasite out of 25-45 did not hatch, accounting for nearly 20% egg-mortality.

First instar larva

Agriotypiform, body elongate, distinctly 13-segmented and characterised by a pair of caudal processes, usually bent at right angles to the long axis of the body, their length equalling the combined length of the first two segments. Head conical, equipped with a pair of short, conical, recurved, highly chitinised mandibles; general coloration of larva pale white, head and first two segments maroon with black; each segment except the 1st and 2nd with a row of backwardly directed spines, more conspicuous ventrally and laterally; spines in the anterior segments longer. The larva is 0.5-0.6 mm long and 0.2 - 0.22 mm wide; caudal processes about one tenth as long as body (0.040-0.05 mm).

The number of first instar larvae per ootheca was found to be 20-36. The larvae move actively, churning the contents of the host eggs. The mortality rate of the parasite at this stage appears to be as high as 50%. Oothecae cut open

about a week after parasitization revealed only 10-18 second instar larvae; this number was found to coincide with the number of dead specimens of the 1st instar, the duration of which was found to 3-5 days. The moulted skins of the first instar larvae appear to be consumed by the later larval stages.

Second instar larva

Hymenopteriform, lacking the conspicuous spines of the preceding stage; body about one and a half times as long as the first instar larva; cylindrical, with short, sparse spinules; caudal processes much reduced, 0.02 mm long, being about one-sixth of the body length, mandibles dark brown; length of larva about 0.75 mm. Colour milky white. Duration 3-4 days.

Third instar larva

Robust, about twice as long as the second instar larva; body smooth, devoid of spines; caudal processes disappearing, caudal segment bilobed; tracheal tubes opening to the exterior by spiracles; spiracles 10 pairs located in the first ten segments. Length 1.5-1.8 mm. Duration 3-4 days.

Fourth instar larva

Similar to the preceding stage, except for its larger size; body distinctly segmented, 2-2.1 mm long; mandibles much reduced; spiracles distinct; coloration light yellow; full grown larva fits snugly into the ootheca, prior to pupation. Duration 3-4 days.

Pupa

As in other species of the family; larval skin of last larval stage forming the cocoon; coloration at first yellowish, gradually turning to light brown, deep brown and black in regular sequence; duration 12-15 days.

Emergence of the adult

The adults were seen moving about within the ootheca for 6-12 hours before one of them cut a circular exit hole of about 0.2 mm diameter. Often, the adults remain within the oothecae for 2 to 3 days or more; in such oothecae for some unknown reason no exit hole is made; if such oothecae are carefully split open, the insects emerge out one by one. Rarely, two exit holes are found on the ootheca located just below the keel at one end of the ootheca. Most of the adults cast off their meconia before emerging from the ootheca, while it is not uncommon to note some adults emerging with the meconia hanging from their abdomen, and they are discarded soon. In some cases, the adults emerge in batches.

A total of 10-18 adults have been noticed to emerge from each ootheca (Table 1).

TABLE 1
DURATION OF EGG AND LARVAL STAGES AND SEX RATIO IN *ANASTATUS* SP.

S. No. Parasitized Ootheca	Duration of egg and larval stages in days	No. of adults emerged	No. of females	No. of males	Sex ratio
1.	32	14	10	04	
2.	30	16	15	01	
3.	28	10	09	01	
4.	28	14	10	04	
5.	26	10	08	02	
6.	26	12	10	02	
7.	35	14	04	10	
8.	30	14	11	03	
9.	25	18	18	—	
10.	27	14	13	01	
11.	27	13	03	10	
12.	35	14	12	02	2:1
13.	30	14	13	01	
14.	32	10	09	01	
15.	32	12	—	12	
16.	35	16	09	07	
17.	30	14	10	04	
18.	26	14	10	04	
19.	9	14	08	06	
20.	26	16	—	16	
Total		271	180	91	

Duration of life-cycle and number of generations per year

The duration from oviposition to the emergence in *Anastatus* sp. was found to be 26 -

35 days at a temperature of 28-31°C and relative humidity of 65-90%. Nearly half of this period is spent on the pupal stage, and as many as 11-12 generations are completed per year if host eggs are accessible.

Adults and their behaviour

The adult female of *Anastatus* sp. measures 2.0 - 3.1 mm long. General coloration black; head jet black, eyes dark metallic black; thorax dark brown; antennae yellowish brown, pedicel pale white; forewings with a transverse fascia at about half the distance from the bases, fringed with fine bristles; hindwings much shorter and smaller than forewings; legs light brown except coxae and trochanters which were black; abdomen black dorsally and light brown ventrally, except the anterior one-third which is pale white. Males much shorter than females, measuring 1.25-1.85 mm long. Abdomen black; forewings extending beyond abdomen.

Like other eupelmids, *Anastatus* sp. is ant-like in its general appearance. Both sexes were quite active, preferring walking as the normal mode of movement, but at the least disturbance they jump vertically. Only under repeated stimulation did they take wing, flying short distances. The jumping habit is perhaps the chief mode of locomotion (Clausen 1940).

Food and Feeding habits

In the present study, adult females of *Anastatus* sp., were observed to puncture the host eggs for oviposition but not for feeding. However, in a few instances, the females were found to feed on the fluid that oozed out of the oviposition puncture. The adults did not appear to feed at all and lived for 2 or 3 days only. Under laboratory conditions it was, however, possible to keep the adults alive for 7-10 days on a diet of dilute honey.

Copulation occurred immediately after emerging from the host ootheca. A single male was found to mate with 1 - 10 females. Females also copulate 1 - 3 times. Copulation lasted 3-16 seconds.

Host selection and oviposition

Anastatus sp. did not demonstrate host specificity, in the laboratory the female oviposited successfully into the oothecae of domiciliary species such as *Supella longipalpa, Blatta orientalis* and *Periplaneta americana.* Its life history in these atypical hosts was not followed up in the present study. After copulation, the female *Anastatus* sp. hunted for the ootheca of the host cockroach; on encountering an ootheca, it tapped the ootheca with the antennae, presumably to test the suitability of the ootheca for oviposition. Oothecae containing eggs that were already parasitized, were decidedly avoided, as was experimentally confirmed in the present study. Antennal sensory cells serve to select the specific site of oviposition in the oothecae. The ovipositor also appeared to have a sensory function — the tip of the ovipositor was gently struck at various points on the ootheca before piercing a specific region. After selecting the oviposition site and sitting on the ootheca with the long axis of its own body at right angles to that of the ootheca, the female inserted the ovipositor and moved it back and forth several times, presumably to anchor the eggs into the host eggs. Oviposition was completed in 35 - 50 minutes, and in one instance it was found to extend over a period of 90 minutes. A single female was found to attack upto three oothecae in quick succession and oviposited in all three. Further, it was observed that a single female oviposited into the same ootheca five times in the course of two hours. Parthenogenesis occurred commonly in *Anastatus* sp. and all the resulting offspring were found to be males.

Sex-ratio

Normally females predominated; often only one male emerged along with 9 - 17 females. However, the mean value of sex-ratio determined from 20 samples clearly showed the predomination of females as 2:1. In some instances, all the individuals emerging from fertilized eggs were male.

Efficiency of biological control

To find out the maximum number of host eggs that could be parasitized, five mated females kept alive in separate test tubes were offered 2, 3, 4, 5 and 6 oothecae. Observations were made from oviposition through development, until the adult parasite emerged. The results (Table 2) revealed that a single female was capable of ovipositing into as many as 3 oothecae, contributing to the control of 36-54 host eggs. It was noteworthy that a maximum of 18 adults of *Anastatus* sp. emerged in certain instances, where the female parasite had access to only one ootheca, while a maximum of 16 adults was found to have emerged when a single female was offered 3 oothecae. However, in many such cases; only 6-12 adults were found to have emerged.

TABLE 2
REALISED REPRODUCTIVE CAPACITY OF *ANASTATUS* SP.

S. No. Female	No. of Oothecae offered	No. of Oothecae parasitized	No. of adult parasites emerged
1.	2	2	11 + 11 = 22
2.	3	3	10 + 09 + 13 = 32
3.	4	2	12 + 14 = 26
4.	5	3	10 + 06 + 12 = 28
5.	6	3	10 + 10 + 16 = 36

DISCUSSION

In the course of this study, it was found that the ootheca of the cockroach *Chorisoneura biligata* was parasitized by the eupelmid species *Anastatus* sp., which showed morphological resemblance to *A. tenuipes* in many respects, but differed in general coloration, size and in the tips of male antennae.

The degree of host specificity of the hymenopterous egg parasites of cockroaches varied. Some parasites were absolutely specific, e.g., the encyrtid parasite, *Comperia merceti* attacked only the ootheca of *Blattella germanica* and would not parasitize the oothecae of *Periplaneta americana* or *B. orientalis* (Lawson 1954). Roth and Willis (1954b) could not induce the eupelmid parasite *Tetrastichus hangenowii* to attack the eggs of *B. germanica* and *Parcoblatta virginica*, its specific host being *Blatta orientalis*. Further, when that eupelmid species oviposited accidentally in the ootheca of *S. longipalpa*, the parasite's eggs either failed to hatch, or if hatched, the larvae died soon. Edmunds (1953) could not induce *Prosevania punctata* to parasitize the eggs of *B.germanica*. Cros (1942) induced this evaniid parasite to oviposit into a mantid ootheca, but neither the mantid eggs nor the parasite developed. In the present study, *Anastatus* sp. which parasitizes the eggs of *C. biligata*, could also oviposit into the oothecae of *P. americana* and *Blatta orientalis* but the eggs deposited into such host eggs failed to develop. All these instances lead to the conclusion that the host specificity of the egg parasites of cockroaches appeared to be rather absolute, and any atypical or abnormal behaviour in this respect interferes with egg viability or results in arrested development of the parasite and the host.

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FOOD AND FEEDING HABIT OF A PENAEID PRAWN *METAPENEOPSIS STRIDULANS* (ALCOCK 1905)[1]

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Key words: Penaeid prawn, *Metapeneopsis stridulans,* food and feeding, Mumbai.

Metapeneopsis stridulans feeds on a variety of food items, viz. diatoms, foraminiferans polychaetes, molluscs, crustaceans and detritus consisting of unidentifiable decaying matter along with sand and mud. The species does not show a preference for any particular food item. There is no significant difference in the food habits among the various size groups observed in the prawn. Monthwise feeding intensity for males and females shows males with empty stomach to be prevalent in most months.

Introduction

Food and feeding habits help to understand the rate of growth, population concentration, maturation of gonads and other metabolic activities of marine organisms. They also help to find links in the food chain and predator - prey relationship in the particular habitat where these organisms occur. Some of the important contributions on food and feeding habits of prawn are of: Williams (1955) on a North American shrimp; Eldred *et al.* (1961) on *Penaeus duorarum*, Hall (1962) on the food of Indo-West Pacific penaeids, Dall (1967) on Australian penaeid prawns. Tiews *et al.* (1972) on Philippine shrimp and Wassenberg and Hill (1987) on the natural diet of Tiger Prawn *Penaeus monodon.* In spite of investigations on food and feeding habits of some Indian marine prawns (Panikkar and Menon 1956, Kunju 1967, George 1959 & 1974, Rao 1988), of several neglected species, which are now gaining economic importance, remain uninvestigated. To fill this lacuna, a study of the food, feeding habits and the feeding intensity of the penaeid prawn *Metapeneopsis stridulans* from Mumbai waters is presented here.

Material and Methods

Metapeneopsis stridulans were collected at Sassoon Dock landing centre (South Mumbai). The gut contents of 673 specimens were analysed sexwise from January to December, 1992. 339 males, ranging from 50 to 90 mm in total length and 334 females, ranging from 40 to 100 mm in total length, were analysed. The animals were cut open and the foregut removed. These were examined and the intensity of feeding was determined by the degree of stomach distension and expressed as full, three-fourths full, half-full, one-fourth full and empty, depending on their fullness. Further, foreguts were dissected and the contents were observed qualitatively under a microscope. The foregut of *Metapeneopsis stridulans* is very minute and the gut contents for the anterior and posterior proventriculus were, therefore, considered together.

Results

A qualitative analysis of the proventriculus of 673 specimens of *Metapeneopsis stridulans* revealed the presence of the following food items:

Diatoms: These were present in the stomach contents in small quantities, with mud and detritus.

Foraminiferans: The shells of foraminiferans were noticed in many guts and in some cases the entire stomach was full of the foraminiferan *Elphidium* sp.

Polychaetes: These worms were easily located by their iridescent setae and jaws, which sometimes occupied the entire proventriculus.

Molluscs: Fragments of gastropod shells and sometimes bivalves were also noticed in the

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stomach. Crushed shells of various forms were observed.

Crustaceans: These formed an important and dominant constituent of the diet, consisting mainly of amphipods, isopods and sometimes *Acetes* sp. Crustaceans were easily identified by the presence of their jointed appendages, plumose setae and stalked eyes.

Fish: Though not often present, fish in the stomach could be identified from their scales, fragments of bones and eye lens.

Detritus: It formed an important item, consisting of unidentifiable decaying matter, along with sand and mud. In general, sand predominated in the stomach of *Metapeneopsis stridulans*.

Miscellaneous: Components seen were bryozoans, shells, filamentous algae and hooks of unidentified animals.

During the present investigation, 301 prawns (44.73 DO) showed empty stomachs, followed by one-fourth full stomach in 113 prawns (16.79 TO), full in 97 prawns (14.41 DO), three-fourths full in 82 prawns (12.18 DO) and half full in 80 prawns (11.89 TO).

Comparing male and female specimens revealed that empty stomachs were more prevalent in males (47.20%) than in females (42.22%). The percentage of females with full stomachs was, however, greater (22.75%) than males (6.19%). In general, the intensity of feeding in males was lower than in females (Table 1).

TABLE 1
FEEDING INTENSITY IN MALES AND FEMALES OF *M. STRIDULANS* (% IN PARENTHESES)

Sex	Total	Full	¾ Full	½ Full	¼ Full	Empty
Male	339	21	39	47	72	160
		(6.19)	(11.50)	(13.86)	(21.24)	(47.20)
Female	334	76	43	33	41	141
		(22.75)	(12.87)	(9.88)	(12.28)	(42.22)
Total	673	97	82	80	113	301
		(14.41)	(12.18)	(11.89)	(16.79)	(44.73)

Monthwise intensity of feeding for males and females is given in Tables 2 and 3 respectively. The data shows that males with empty stomachs were more prevalent in most of the months. However, the percentage of these prawns was higher in May (84%), October (77.27%) and September (76%). Males with full stomach were noticed during November - February and July - August.

Females with empty stomach were also encountered in most months except December. The percentage of empty stomachs was higher in September (68%), May (65.38%) and November (73.33%). Females with full stomachs were observed during December (85%), January (41%) and August (33.33%).

In order to study the relation of size to intensity of feeding, males and females were grouped into size groups of 10 mm. Sizewise fullness of stomach shows (Table 4) that prevalence of empty stomach is 71.42% in the 50-60 mm size-group, followed by 58.16% in 60-70 mm, 49.39% in 70- 80 mm and 25.67% in 80-90 mm. Thus, the percentage of empty stomach in males decreases with increase in length. Conversely, the percentages of full and three-fourths full stomachs show an increasing trend with increase in length.

The size-related intensity of feeding in females and males showed similar trends, the full and three-fourths full stomach exhibiting predominance with increase in length (Table 5).

Empty stomach among immature (40%), early maturing (43.22%) and mature (43.05%) prawns is nearly equal; the predominance of full and three-fourths full in females shows an increasing trend of feeding as they mature (Table 6).

DISCUSSION

Investigations have shown that penaeid prawns have varied food habits. Gopalakrishnan (1952) showed that *Penaeus indicus* is an omnivorous species feeding on crustaceans and

TABLE 2
MONTHWISE FEEDING INTENSITY OF MALE
M. STRIDULANS (% IN PARENTHESES)

Months	Prawns analysed	Full	¾ Full	½ Full	¼ Full	Empty
Jan.	77	9 (11.69)	11 (14.28)	14 (18.18)	30 (38.96)	13 (16.88)
Feb.	44	3 (06.81)	5 (11.36)	6 (13.64)	15 (34.09)	15 (34.09)
Mar.	7	-	1 (14.29)	1 (14.29)	1 (14.29)	4 (57.14)
Apr.	24	-	8 (33.33)	4 (16.67)	3 (12.50)	9 (37.50)
May	25	-	-	1 (04.00)	3 (12.00)	21 (84.00)
Jun.	19	-	2 (10.53)	2 (10.53)	4 (15.79)	12 (63.16)
Jul.	22	1 (04.55)	-	2 (09.09)	4 (18.18)	15 (68.18)
Aug.	24	2 (08.33)	4 (16.67)	7 (29.17)	1 (04.17)	10 (41.67)
Sep.	25	-	1 (04.00)	3 (12.00)	2 (08.00)	19 (76.00)
Oct.	22	-	1 (04.55)	3 (13.64)	1 (04.55)	17 (77.27)
Nov.	20	2 (10.00)	1 (05.00)	1 (05.00)	3 (15.00)	13 (65.00)
Dec.	30	4 (13.33)	5 (16.67)	3 (10.00)	6 (20.00)	12 (40.00)
Total	339	21 (06.19)	39 (11.50)	47 (13.86)	72 (21.24)	160 (47.20)

TABLE 3
MONTHWISE FEEDING INTENSITY OF FEMALE
M. STRIDULANS (% IN PARENTHESES)

Months	Prawns analysed	Full	¾ Full	½ Full	¼ Full	Empty
Jan.	39	16 (41.03)	8 (20.51)	3 (97.69)	8 (20.51)	4 (10.26)
Feb.	6	2 (33.33)	1 (16.67)	1 (16.67)	1 (16.67)	1 (16.67)
Mar.	46	12 (26.09)	9 (19.57)	4 (08.70)	3 (06.52)	8 (39.13)
Apr.	28	1 (03.57)	3 (10.71)	3 (10.71)	7 (25.00)	14 (50.00)
May	26	1 (03.84)	4 (15.38)	2 (07.69)	2 (07.69)	17 (65.38)
Jun.	32	7 (21.88)	3 (09.38)	8 (25.00)	7 (21.88)	7 (21.88)
Jul.	28	5 (17.86)	2 (07.14)	2 (07.14)	2 (07.14)	17 (60.71)
Aug.	27	9 (33.33)	6 (22.22)	2 (07.41)	1 (03.70)	9 (33.33)
Sept.	25	1 (04.00)	-	2 (08.00)	5 (20.00)	17 (68.00)
Oct.	27	3 (11.11)	5 (18.52)	1 (03.70)	3 (11.11)	15 (55.56)
Nov.	30	2 (06.67)	-	4 (13.33)	2 (06.67)	22 (73.33)
Dec.	20	17 (85.00)	2 (10.00)	1 (05.00)	-	-
Total	334	(22.75)	43 (12.87)	33 (09.88)	41 (12.28)	141 (42.22)

TABLE 4
FEEDING INTENSITY OF MALE *M. STRIDULANS*
(% IN PARENTHESES) AS PER SIZE

Size (mm)	Full	¾ Full	½ Full	¼ Full	Empty	Total No. of Prawns examined
40-50	-	-	-	-	-	-
50-60	-	1 (14.29)	1 (14.29)	-	5 (71.43)	7
60-70	3 (03.06)	8 *08.16)	16 (16.33)	14 (14.29)	57 (58.16)	98
70-80	8 (05.00)	17 (10.63)	19 (11.86)	37 (23.13)	79 (49.38)	160
80-90	10 (13.51)	13 (17.57)	11 (14.86)	21 (28.38)	19 (24.68)	74
90-100	-	-	-	-	-	-
Total	21 (06.19)	39 (11.50)	47 (13.86)	72 (21.24)	160 (47.20)	339

TABLE 5
FEEDING INTENSITY OF FEMALE *M. STRIDULANS*
(% IN PARENTHESES) AS PER SIZE

Size (mm)	Full	¾ Full	½ Full	¼ Full	Empty	Total No. of Prawns examined
40-50	-	-	-	-	1	1
50-60	1 (05.56)	1 (05.56)	2 (11.11)	2 (11.11)	12 (66.67)	18
60-70	11 (14.29)	11 (14.29)	8 (10.39)	11 (14.29)	36 (46.75)	77
70-80	33 (22.30)	16 (10.81)	14 (09.46)	21 (14.19)	64 (43.24)	148
80-90	29 (33.72)	13 (15.11)	9 (10.47)	7 (08.14)	28 (32.56)	86
90-100	2 (50.00)	2 (50.00)	-	-	-	4
Total	76 (22.75)	43 (12.87)	33 (09.88)	41 (12.28)	141 (42.22)	334

TABLE 6
FEEDING INTENSITY OF FEMALE *M. STRIDULANS* IN DIFFERENT MATURITY STAGES (% IN PARENTHESES)

Maturity stage	Full	¾ Full	½ Full	¼ Full	Empty	Total No. of Prawns examined
I	13 (20.00)	7 (10.77)	6 (09.23)	13 (20.00)	26 (40.00)	65
II	39 (20.31)	24 (12.50)	24 (12.50)	22 (11.46)	83 (43.23)	192
III	20 (27.78)	12 (16.67)	3 (04.17)	6 (08.33)	31 (43.06)	72
IV	2 (100.00)	-	-	-	-	2
V	2 (66.67)	-	-	-	1 (33.33)	3
Total	76 (22.75)	43 (12.87)	33 (09.88)	41 (12.27)	141 (42.21)	334

vegetable matter, which form the bulk of the gut contents. Panikkar and Menon (1956) have concluded that the food of prawns consists of detritus of both animal and plant origin, which accumulates at the bottom of the habitat. The prawns *Metapenaeus dobsoni*, *Penaeus stylifera* and *P. indicus,* prefer area of muddy habitat indicating their preference for detritus. However, Hall (1962) stated that penaeids in general cannot be considered as detritus feeders. The gut contents of *Metapenaeus monoceros* has shown the presence of small crustaceans along with sand grains and mud, while detritus was of less importance (George 1974).

The present study reveals that *Metapeneopsis stridulans* is not predominantly a detritus feeder but a carnivore, feeding on crustaceans, molluscs, small fishes and polychaetes. Moreover, it also feeds on foraminiferans in the benthic region and takes up diatoms, sand particles, mud and detritus along with them. These results agree with the conclusions of Hall (1962) that prawns are carnivorous.

Low feeding intensity, indicated by the prevalence of empty, one-fourth full and half-full stomachs during maturation and pre-spawning period is widely known in fishes. In penaeid prawns, major expansion of ovary during maturation takes place in the abdominal region (Rao, 1968). The gut of prawns is located in the cephalothorax, in which ovarian expansion is less; therefore, the prevalence of full and three-fourths full stomachs in mature female prawns does not seem to be affected. In fact, the females must feed intensively in order to derive more energy for reproductive output during maturation. The presence of a larger number of full and three-fourths full stomachs in mature females and the increasing order of intensity with maturity supports this view. Higher feeding intensity, as indicated by a greater number of full and three-fourth full stomachs during the breeding period, i.e., December to January, also corroborates this view.

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FRESHWATER CLADOCERA (CRUSTACEA) OF SOUTHERN TAMIL NADU[1]

K. VENKATARAMAN[2]

(*With four text-figures*)

Key words: Cladocera, 46 species, Tamil Nadu, freshwater, wetlands.

The investigation on the taxonomy of Cladocera shows that about 46 species belonging to five families Sididae, Daphniidae, Moinidae, Macrothricidae and Chydoridae are represented in and around southern Tamil Nadu, of which 34 are new records. The species composition of Cladocera in the present study has some features unique to this region. Leptodoridae, Halopedidae and Polyphemidae are absent and species belonging to the genera *Pleuroxus* as well as *Ceriodaphnia* are scarce. Only four species of Cladocera are distinctly dominant in the limnetic zooplankton of southern Tamil Nadu. They are *Daphnia similis, Ceriodaphnia cornuta, Moina micrura* and *Diaphanosoma excisum*. Littoral regions of the wetlands of southern Tamil Nadu are dominated by *Pseudosida bidentata* and *Latonopsis australis,* two co-occurring members of the family Sididae. The tropicopolitan and cosmopolitan forms of Cladocera predominate the southern Tamil Nadu wetlands. Two unexpected species *Daphnia longicephala* and *Daphnia projecta* are recorded for the first time in India. Two rare species, namely *Alona* cf. *karelica* and *Graptoleberis testudinaria* were also found in the present study.

INTRODUCTION

Though the Cladocera of the Indian region have been studied by different authors, those of South India, especially Tamil Nadu, have received scant attention. Michael (1973) and Murugan and Job (1981) have briefly dealt with a few species occurring in and around Madurai, Tamil Nadu.

The present work on the taxonomy of Cladocera of southern Tamil Nadu was conducted in Madurai, Ramnad, Tirunelveli and Kanyakumari districts. Extensive and intensive sampling was undertaken in 1979 and all the available species were studied in detail. Over 700 samples were collected from various types of habitats and a total of 46 species of Cladocera were identified, of which 34 were recorded for the first time from this region.

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MATERIAL AND METHODS

The sampling sites are shown in Fig. 1. Plankton nets with 36 cm diameter were used. The net was dragged among the vegetation close to the bottom of the shallow waters in marshes. Oblique hauls were taken to obtain zooplankton from the shores of the man-made reservoirs and ponds.

The concentrated samples were preserved in 5% and 10% formalin with one teaspoon per litre sugar and 95% glycerine alcohol and were stored in 50 or 100 ml plastic containers for taxonomic studies. The technique of Fernando (1980a) was adopted to prepare the head-shields of species of Chydoridae. The specimen was placed on a cavity slide containing concentrated HCl, heated and later cooled. The head shield was carefully dissected out and permanently mounted using Lactophenol and Canada balsam. Mounts of the entire specimen were also made for Macrothricidae, Moinidae and Chydoridae.

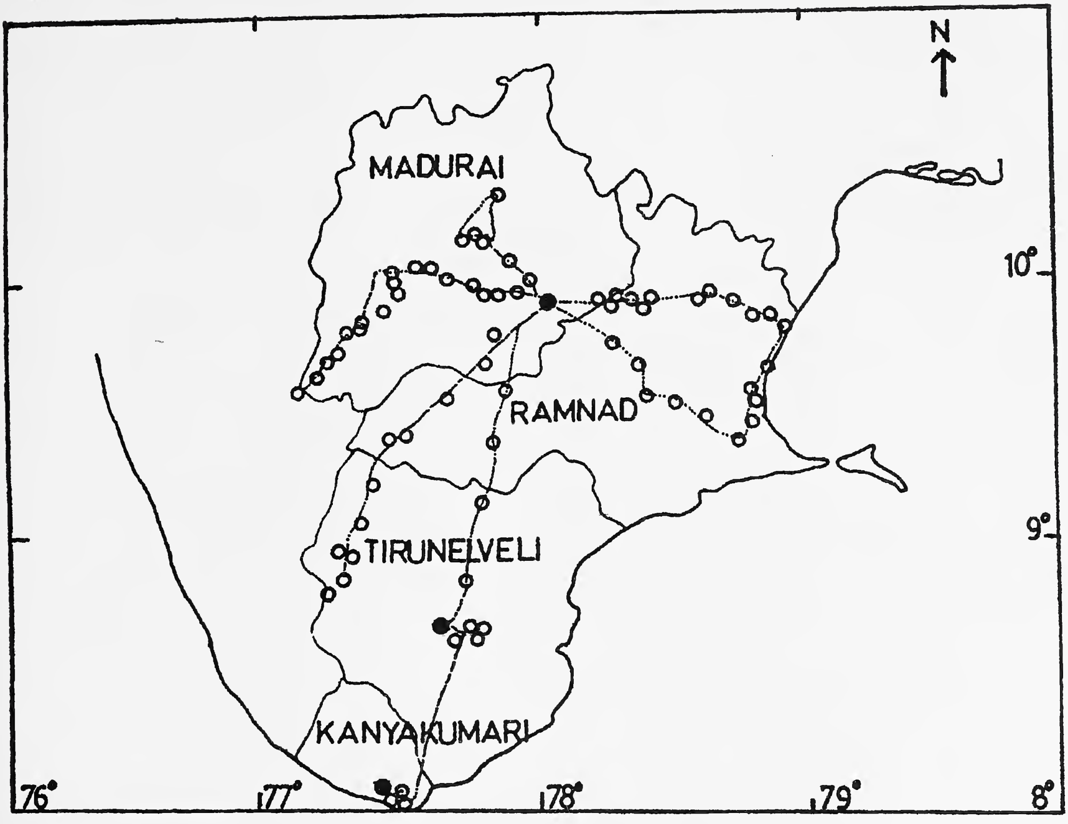

Fig. 1: Area where Cladocera samples were collected for study in southern Tamil Nadu

Results

Detailed study of the collections revealed the occurrence of 46 species of Cladocera belonging to 23 genera and 5 families (Table 1). A systematic account of a few of the rare species recorded in the present study are given below.

Family Daphniidae

1. ***Daphnia longicephala*** Hebert 1977 (Fig. 2)

Female: Body size 4.2 mm. Anterodorsal cephalic crest present; shape and length of the crest vary; dorsal margin with well developed spines; rostrum acute, extends up to ventral carapace margin. Eye situated well away from the margin; ocellus often absent, if present very minute. Postabdomen with 8-12 anal spines; claw with 9-10 proximal, 14-16 middle and 28-36 distal pectens.

Distribution: Southern Tamil Nadu: Madurai and Ramnad dist. Elsewhere: Single report from New South Wales (Hebert 1977). This is the first record of its occurrence in India.

Remarks: Well developed anterodorsal helmet and conspicuous spines on the dorsal margin are distinguishing characters which separate this species from *D. cephalata* King. However, Grant and Bayly (1981) reported that the present species is only a polymorphic species

TABLE 1
SPECIES OF CLADOCERA RECORDED FROM SOUTHERN TAMIL NADU AND OTHER REGIONS OF INDIA AND SOUTHEAST ASIA

Sl. No.	Name of species	Previous records from Tamil Nadu including Northern Districts	North-eastern India (West Bengal and and Tripura)	Andaman and Nicobar Island	Sri Lanka	Malaysia	Distribution (Present study)
	Family SIDIDAE Sars						
	Genus *Latonopsis* Sars						
1.	*L. australis* Sars	—	4,5	6	7	8	common
	Genus *Pseudosida* Herrick						
2.	*P. bidentata* Herrick, 1884	—	4,5	6	7	8	common
	Genus *Diaphanosoma* Fischer						
3.	*D. excisum* Sars	1,3	4,5	6	7	8	very common
4.	*D. sarsi* Richard	3	4,5	6	7	8	very common
5.	*D. senegalensis* (Gauthier)	—	—	—	—	—	common
	Family DAPHNIIDAE Stratus						
	Genus *Daphnia* Muller						
	Subgenus *Ctenodaphnia* Dybowski & Grochoski						
6.	*D. similis* Claus	—	4	—	7	8	common
7.	*D. cephalata* King	1	—	—	7	—	common
8.	*D. longicephala* Hebert	—	—	—	—	—	rare
9.	*D. projecta* Hebert	—	—	—	—	—	very rare
10.	*D. lumholtzi* Sars	1,2,3	4,5	—	7	—	common
	Genus *Simocephalus* Schdler						
11.	*S. acutirostratus* (King)	1, 2	5	—	7	—	common
12.	*S. vetulus elizabethae* (King)	—	4,5	—	7	—	common
13.	*S. serrulatus* (Koch)	—	5	—	—	8	very rare
14.	*S. latirostris* Stingelin	—	5	—	—	8	rare
15.	*S. exspinosus* (Koch)	—	—	—	7	—	rare
	Genus *Scapholeberis* Schdler						
16.	*S. kingi* Sars	1,2	4,5	6	7	8	common
	Genus *Ceriodaphnia* Dana						
17.	*C. cornuta* Sars	1,2,3	4,5	6	7	8	common
	Family MOINIDAE Goulden						
	Genus *Moina* Baird						
18.	*M. micrura* Kurz	1,2,3	4,5	6	7	8	common
19.	*M. weismanni* Ishikawa	—	4	—	—	—	rare
	Family MACROTHRICIDAE Norman Brady						
	Genus *Ilyocryptus* Sars						
20.	*I. spinifer* Herrick	—	4,5	6	7	8	common
	Genus *Macrothrix* Baird						
21.	*M. laticornis* (Jurine 1820)	3	—	6	—	—	rare
22.	*M. spinosa* King	1,3	4,5	6	7	8	common
23.	*M. triserialis* Brady	—	4,5	6	7	8	common

TABLE 1 (*contd.*)
SPECIES OF CLADOCERA RECORDED FROM SOUTHERN TAMIL NADU AND OTHER REGIONS OF INDIA AND SOUTHEAST ASIA

Sl. No.	Name of species	Previous records from Tamil Nadu including Northern Districts	North-eastern India (West Bengal and and Tripura)	Andaman and Nicobar Island	Sri Lanka	Malaysia	Distribution (Present study)
	Family CHYDORIDAE Stebbing						
	Subfamily Chydorinae Frey						
	Genus *Pleuroxus* Baird						
24.	*P. aduncus* (Jurine)	—	—	—	—	—	rare
	Genus *Dadaya* Sars						
25.	*D. macrops* (Daday)	—	5	6	7	8	common
	Genus *Chydorus* Leach						
26.	*C. parvus* Daday	—	—	6	7	8	common
27.	*C. ventricosus*	—	4, 5	6	7	8	common
28.	*C. eurynotus* Sars	—	—	6	7	8	common
	Genus *Ephemeroporus* Frey						
29.	*E. barroisi* Richard	—	4,5	6	7	8	common
	Genus *Dunhevedia* King						
30.	*D. crassa King*	—	4,5	6	7	8	common
31.	*D. serrata* Daday	—	4,5	6	7	8	common
	Genus *Pseudochydorus* Fryer						
32.	*P. globosus* (Baird)	—	4,5	—	7	—	rare
	Subfamily Aloninae Frey						
	Genus *Alona* Baird						
33.	*A. monocantha tridentata* (Stingellin)	—	4,5	6	7	8	common
34.	*A. davidi* Richard	—	4,5	6	7	8	common
35.	*A.* cf. *karelica* Stenroos	—	—	—	—	8	very rare
36.	*A. pulchella* King	—	4,5	6	7	8	common
37.	*A. sarasinorum* Stingelin	—	—	—	—	8	very rare
	Genus Graptoleberis Sars						
38.	*G. testudinaria* (Fischer)	—	4	—	7	8	very rare
	Genus *Kurzia* Dybowski & Grochowski						
39.	*K. longirostris* (Daday)	2	4	6	7	8	common
	Genus *Leydigia* Kurz						
40.	*L. ciliata* (Gauthier)	—	—	—	—	—	rare
41.	*L. australis* Sars	—	—	6	7	—	common
42.	*L. acanthocercoides* (Fischer)	1,2	4,5	6	7	8	common
	Genus *Biapertura* Smirnov						
43.	*B. karua* (King)	—	4,5	6	7	8	common
44.	*B. verrucosa* Sars	—	4,5	6	7	8	common
	Genus *Oxyurella* Dybowski & Grochowski						
45.	*O. sinhalensis* (Daday)	—	4,5	6	7	8	common
	Genus *Euryalona* Sars						
46.	*E. orientalis* (Daday)	—	4,5	6	7	8	common

(1 — Michael 1973; 2 — Murugan and Job 1981; 3 — Raghunathan 1983; 4 — Venkataraman 1993; 5 — Venkataraman 1995; 6 — Venkataraman 1992; 7 — Rajapaksa and Fernando 1982; 8 — Idris 1983).

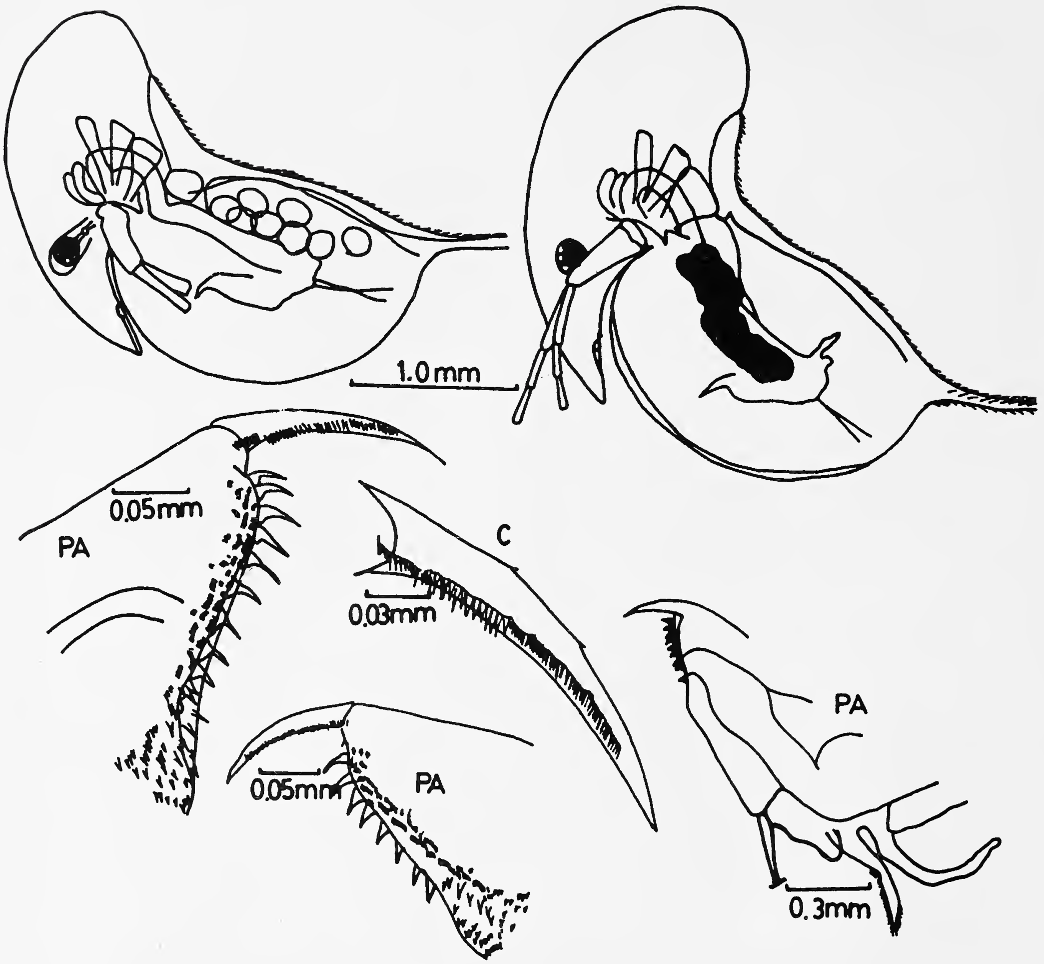

Fig. 2: *Daphnia longicephala*, Female: PA - postabadomen; C - claw.

of *D. carinata* King. Michael (1973) and Santharam (1978) described a daphnid as *D. cephalata* resembling *D. longicephala* Hebert from a pond near Madurai. The specimens examined in this study agree with Michael's and Santharam's descriptions.

2. ***Daphnia projecta*** Hebert 1977 (Fig. 3)

Female: Body size 2.2 mm. Dorsoanterior helmet; eye small; ocellus inconspicuous. Rostrum slightly recurved and pointed. Strong carapace spines; tail long, equal to the length of carapace. Postabdomen with 8-12 anal spines. Reproductive females less than 1.5 mm.

Male: Body size 1 mm. Head large with anterior helmet; rostrum absent, dorsal margin of head and body straight with spines. Antennules movable; flagellum not well developed. Eye large and ocellus inconspicuous. First pair of legs modified to form prehensile organ with a long seta. Postabdomen with 10-12 anal spines.

Distribution: Southern Tamil Nadu: Madurai, Ramnad and Tirunelveli dist. Elsewhere: Australia.

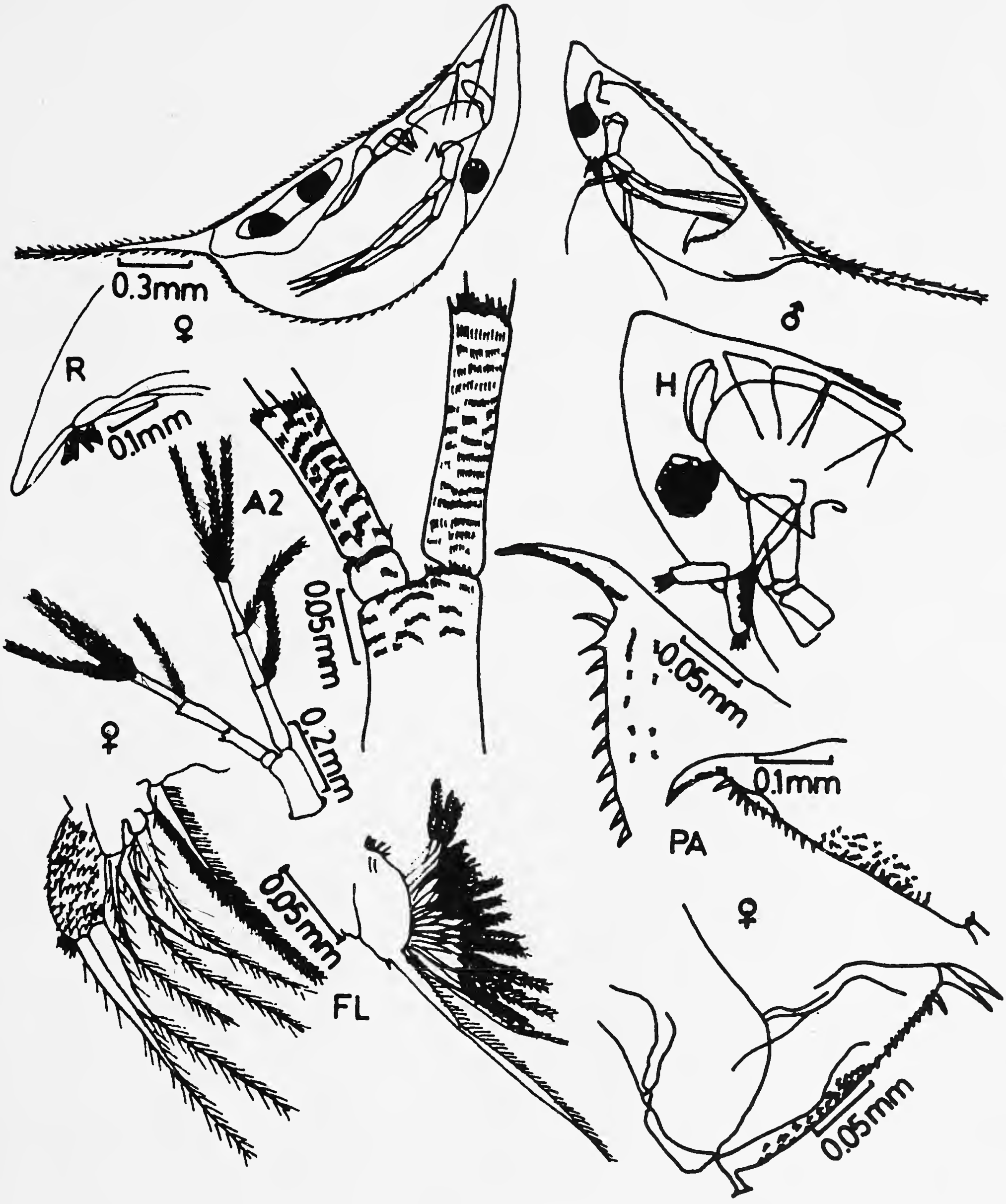

Fig. 3: *Daphnia projecta*, Female: R - rostrum; A2 - antenna; FL - first leg; PA - postabdomen. Male: H - head.

Remarks: This is the first report of the occurrence of this species outside Australia. It was considered endemic to Australia (Hebert 1977). The present study extends its distribution to this region. Hebert (1977) recorded this species as one of the commonest planktonic forms in the temperate region (Australia). So far, it has not been recorded from tropical Asia, southeast Asia, Africa and America. The present description of this species extends its distribution to southern Tamil Nadu.

3. ***Simocephalus sérrulatus***
(Koch 1841)

Female: Body size 1.35 mm. Body oval; posterior region wide. Dorsal margin evenly arched and ventral margin bulging in middle. Head small; eye large. Anteriormost region of head with a number of minute denticles. Ocellus rhomboidal in shape. Postabdomen with 6-8 anal denticles. Claw without pecten and setules on concave margin.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: Australia, Africa, China, Europe and Southeast Asia.

Family Moinidae

4. ***Moina weismanni*** Ishikawa 1896

Female: Body size 0.9-1.0 mm. Hairs present on head and body. Antennules ornamented with spines with a sensory seta at the middle. Postabdomen with 7-9 feathered setae. Ephippia with raised knobs at the centre.

Male: Body size 0.77 mm. Four hooks on the antennule of male. Hook on the first leg not well developed.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: Cambodia, China and Japan.

Remarks: Under the genus *Moina,* so far only two species, namely *M. micrura* and *M. macrocopa*, have been reported from India. *M. weismanni* is a new record for India.

Family: Macrothricidae

5. ***Macrothrix laticornis*** (Jurine 1820)

Female: Body size 0.43-0.55 mm. Head rounded; rostrum small with two antennules. Ventral margin of carapace with movable spines. Postabdomen with numerous fine spines.

Distribution: Southern Tamil Nadu: Madurai and Ramnad dist. Elsewhere: Nepal, China, Bangladesh, Africa, North and South America and Europe.

Remarks: Dumont and Van der Velde (1977) compared the materials from Belgium (*M. laticornis*), Australia (*M. spinosa*) and Israel (*M. goeldii*) and pointed out that *M. laticornis* may occur in tropical regions as well as coexist with *M. spinosa*.

Family Chydoridae

6. ***Pleuroxus aduncus*** (Jurine 1820)

Female: Body size 0.47 mm. Head small. Antennules with pegs near the base, reaching the middle of rostrum. Labrum with pointed apex. Posteroventral corner with varying number of spines. Valves with lines on the anteroventral region. Postabdomen with 10 denticles decrease in length proximally. Claw with two basal spines.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: India - Rajasthan; Nepal, Africa and South America.

Remarks: *P. aduncus* is a cosmopolitan species. Smirnov (1974) described four subspecies.

7. ***Chydorus parvus*** Daday 1898

Female: Body size 0.35 mm. Head small; antennules not reaching the apex of rostrum. Ocellus situated nearer to eye than to the apex. Posteroventral corner without denticles. Anterior margin of valves with tubercles on the inner side. Postabdomen with 9-10 denticles.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere - Nepal, Sri Lanka, Malaysia and Africa.

Remarks: This species can be recognised by the presence of tubercles on the surface of anterior margin of valves.

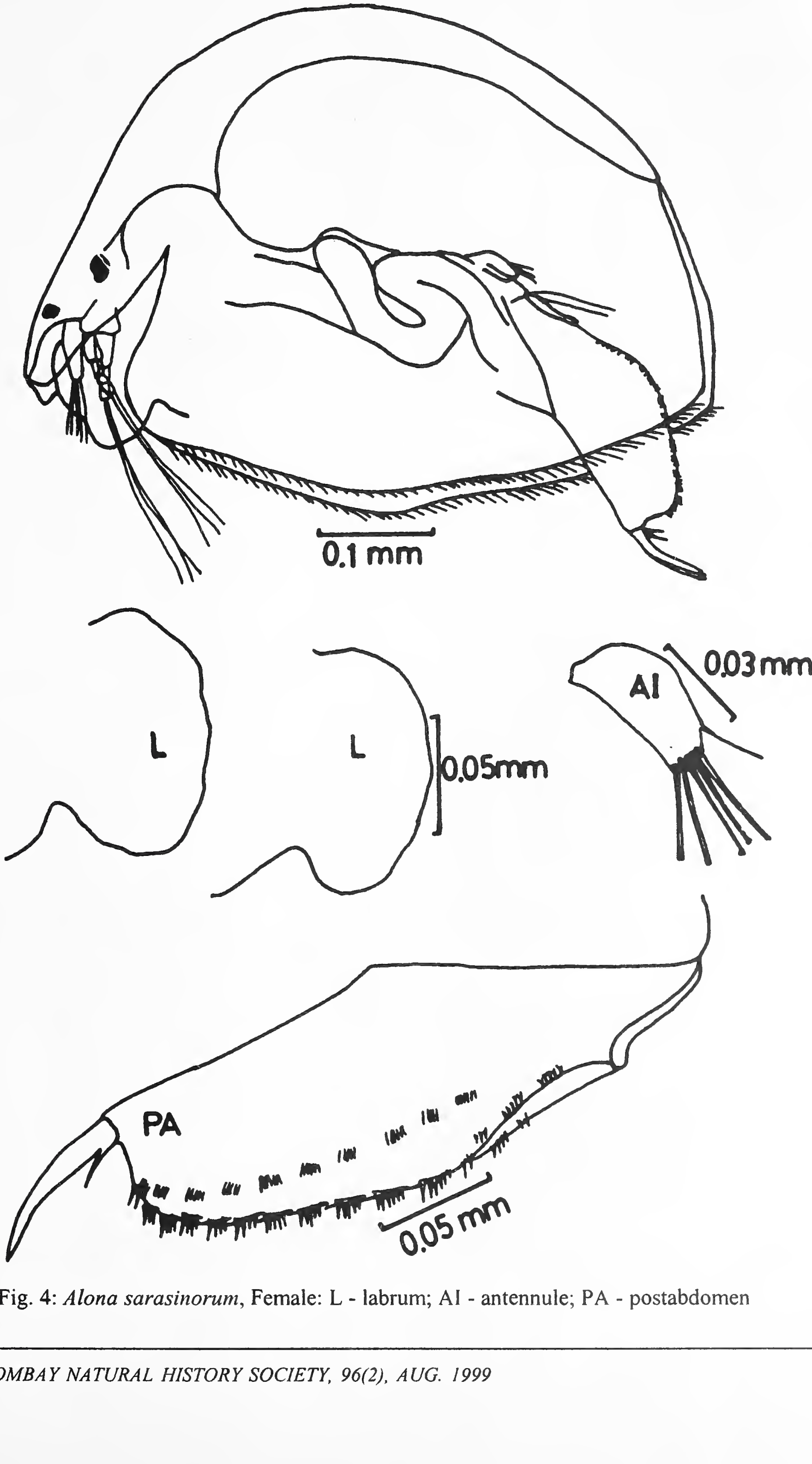

Fig. 4: *Alona sarasinorum*, Female: L - labrum; AI - antennule; PA - postabdomen

8. ***Pseudochydorus globosus***
(Baird 1843)

Female: Body size 0.4-0.7 mm. Head small with pointed rostrum. Anteroventral margin of valve with concentric stripes and hexagonal cells. Postabdomen with 15 anal denticles. Claw with two basal spines.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: India - Rajasthan; Sri Lanka, Malaysia, Australia, Africa and China.

Remarks: The genus *Pseudochydorus* was established by Fryer (1968) on the basis of significant differences noticed in the trunk limbs of other species of *Chydorus*. This is the first record of *P. globosus* in Tamil Nadu.

9. ***Alona* cf *karelica*** Stenroos 1897

Female: Body size 0.4 mm. Head small, rostrum blunt. Ocellus slightly smaller than eye, situated halfway between eye and apex of rostrum. Labrum rounded with a slightly pointed apex. Postabdomen with distal dorsal end projecting beyond the base of claw; anal margin concave; preanal corner projecting, 8-10 anal denticles with small setae on the inner margin; claw with a basal spine.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: Malaysia, Germany and Northwest Europe (erstwhile USSR).

Remarks: This species was originally described from temperate regions. Idris and Fernando (1981) reported this species from Malaysia.

10. ***Alona sarasinorum*** Stingelin 1900
(Fig. 4)

Female: Body size 0.52 mm. Head small; rostrum blunt. Antennules almost reaching the apex of rostrum. Ocellus slightly smaller than eye. Labrum rounded anteriorly and acutely rounded posteroventrally. Ventral margin of valves with a series of setae, with setules between the setae. Postabdomen with 12 groups of denticles. Claw with a basal spine.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: Malaysia, Indonesia.

Remarks: Only a few specimens were found in a pond, in the Madurai Kamaraj University Campus, Madurai. A collection from Murugan temple pond at Port Blair containing *A. sarasinorum* in good quantity resembles the present description. Insufficient information in previous descriptions makes it difficult to identify this species.

11. ***Graptoleberis testudinaria*** (Fischer 1848)

Female: Body size 0.6 mm. Head large with the tip of rostrum semicircular. Antennules not reaching the apex of rostrum. Labrum rounded. Ocellus smaller than eye. Posteroventral corner of valves with three denticles. Postabdomen with 6-8 lateral groups of setae present; claw without basal spine.

Distribution: Southern Tamil Nadu: Madurai. Elsewhere: Sri Lanka, Malaysia, Nepal, Australia and South America.

Remarks: The number of denticles present in the posteroventral corner of the valve may differ in number on the left or right valve or be absent (Smirnov 1974). Sklyarova (1947) reported five denticles, Gauthier (1928) four and in the present study three were found. Smirnov (1974) has described five subspecies.

12. ***Leydigia ciliata*** (Gauthier 1939)

Female: Body size 1.00 mm. Head small. Ocellus triangular in shape; equal in size with eye. Antennules not reaching the apex of rostrum. Labrum undulate, with hairs on anterior margin. Periphery of valves with rows of granules. Postabdomen wide, with groups of lateral setae; anal denticles small; anal margin slightly convex with setae; claws with a small basal spine and setae.

Male: Body size 0.65 mm. Antennule with spear-like setae on the distal margin. Vas deferens open at apex of a penis-like process on the dorsal side of postabdomen. First leg with a hook.

Distribution: Southern Tamil Nadu: Madurai, Ramnad, Tirunelveli and Kanyakumari dist. Elsewhere: Nepal, China, Africa, Australia and South America.

Remarks: The present material collected at Madurai, Ramnad, Tirunelveli and Kanyakumari dist. agrees with Harding's (1955) description in the size of the ocellus which is slightly bigger than the eye, in the antennules not reaching the tip of the rostrum, and in the presence of a claw with a basal spine.

Discussion

The Cladoceran fauna of southern Tamil Nadu exhibit certain features unique to the region. A total of 46 species belonging to 5 families have been recorded in the present study, out of which 34 are new records.

The species spectrum of limnetic Cladocera is far more limited in the tropics than in temperate regions (Fernando 1980a). However, in southern Tamil Nadu, which is located in tropical India, as many as five species of *Daphnia*, namely, *D. similis*, *D. cephalata*, *D. longicephala*, *D. projecta* (records in present investigation) and *D. lumholtzi* (Michael 1973; Murugan and Job 1981), all of them probably temperate in origin, were found to occur. This is rather unusual, as the genus *Daphnia* is normally the most evident absentee from tropical freshwaters (Fernando 1980b). However, there are previous records of *D. lumholtzi* by Poppe and Mrajek (1895) (misidentified as *D. galeate,* Fernando 1980b) and three species of *Daphnia* in Sarawak (Spandal, 1924) and the relatively large number of *D. similis* recorded in Thailand, which Fernando (1980b) considers as probable introductions. Several explanations are given on the mode of such introductions. Birds have been considered an important agency for the dissemination of microcrustaceans in freshwaters (Thienemann 1950; Loffler 1963; Smirnov 1974). In fact, rice fields attract aquatic bird migrants. Import of food grains is another important means of transporting alien Cladocera into the country (Mukhamediev 1951; Mizuno and Mori 1970).

The species composition of limnetic Cladocera of southern Tamil Nadu is typical of tropical regions. The marked differences in the number of limnetic species in tropical and temperate regions is conspicuous, as pointed out by Fernando (1980a, b). Only four species of Cladocera, which are eurytopic, occurring in a wide range of habitats, were found to be distinctly dominant in the limnetic zooplankton of southern Tamil Nadu, as is the case with the entire southeast Asian regions (Fernando 1980b). They are *Daphnia similis, Ceriodaphnia cornuta, Moina micrura* and *Diaphanosoma excisum* (Table 1).

It is interesting to note that large Cladocera found in the littoral zone of temperate regions, namely *Eurycercus* and *Saycia,* the largest Chydoridae, are completely absent from the tropical region (Frey 1971). In the present study, two co-occurring members of the family Sididae, *Pseudosida bidentata* and *Latonopsis australis* were found to dominate the littoral region. Among the five species of the genus *Simocephalus, S. acutirostratus* and *S. vetulus elizabethae* occurred in most of the littoral samples. However, they are rarer here than in the temperate region where this genus is abundant. Further, *Scapholeberis kingi* and *Dadaya macrops,* the two epineustic pantropical Cladocera, as well as *Euryalona orientalis* are very common in the littoral region of southern Tamil Nadu. Two species of the family Bosminidae reported from Sri Lanka (Rajapaksa and Fernando 1982) and other Southeast Asian tropical regions were not found during the present study.

Comparison of the species diversity and size spectrum of Cladocera from tropical and temperate regions reveals a marked difference, the species size and spectrum being much smaller in the tropics than in temperate regions. In the present study, the lower end of the size range

was found to be occupied by *Dadaya macrops* (0.4 mm). Two of the largest forms, *Daphnia cephalata* and *Daphnia longicephala* reach a maximum size of 3.5 - 5.0 mm, while the same species reach 5.0 - 6.0 mm in temperate Australia (Hebert 1977).

While assessing the reasons for fewer and smaller Cladocera occurring in tropical lentic waters, the role of various factors like evolutionary history, physiology, population dynamics, temperature, availability of food and predator pressure should be carefully weighed (Fernando 1980b). Lack of large standing freshwaters (lakes) in southern Tamil Nadu, both in space and time, could account for limited Cladoceran fauna. The uniform high temperature prevailing in this region might have restricted niche diversity seasonally, thus reducing the number of species, as pointed out by Fernando (1980b).

Temperature has many direct and indirect effects on the species diversity and size range of *Daphnia.* In the present study, the small-sized *Daphnia similis* (2.2 mm) appeared to dominate the temporary ponds. However, the larger species, *D. cephalata* and *D. longicephala* also occur in limited numbers. In the tropics, the prevailing temperature lowers fecundity and feeding efficiency (Fernando 1980b), thus accounting for the absence of larger *Daphnia.* Also, it has been shown that feeding efficiency in *Daphnia* increases with size (Burns and Rigler 1967), but the optimum size decreases with the rise in temperature (Lynch 1977).

It is generally accepted that the major factor in reducing the size of zooplankton is predation by fish (Harbacek 1977). In the present study, in the river-fed man-made reservoirs with large numbers of planktivorous fish, larger daphnids like *D. cephalata* and *D. longicephala* are conspicuous by their absence, or rapid disappearance, due to this reason. This is in conformity with the observations of many earlier workers (Zaret and Kerfoot 1975; O'Brien, *et al.* 1976; Fernando 1980a, b). In the absence of vertebrate planktivores, larger invertebrate predators like *Anisops bouveri* are found to be the dominant feeders upon small to intermediate-sized cladocerans.

In the present study, the tropical (*Dadaya macrops, Dunhevedia serrata, Ceriodaphnia cornuta, Diaphanosoma excisum, Scapholeberis kingi*) and cosmopolitan (*Pleuroxus aduncus, Pseudochydorus globosus, Moina micrura, Pseudosida bidentata, Alona karna*) forms predominate. A few endemic cladocerans such as *Alona macronyx* Daday, *Indialona ganapati* Petkovski and perhaps some *Alona* spp. found in Southeast Asia were not recorded in this study (Table 1). However, the more interesting Cladocera found during the present study are those which were earlier not expected to occur in this region, rare forms which are being recorded for the first time from a tropical region. Also, *Alona* cf *karelica* Stenroos (1897) believed to occur only in Northern Europe was earlier recorded in Malaysia (Idris and Fernando 1981) and now in this study.

Many more Cladocerans may be found to be widely distributed. Daday (1898) recorded *Graptoleberis testudinaria* and described *Indialona macronyx* from Sri Lanka. The former species is a rare form in the tropics (Fernando 1980a). However, it is recorded for the first time in southern Tamil Nadu.

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NEW DESCRIPTIONS

NEW SPECIES OF *AGONISCHIUS* CANDEZE (COLEOPTERA, ELATERIDAE : LUDIINAE) FROM INDIA[1]

PUNAM GARG AND V. VASU[2]

(*With six text-figures*)

Key words: new species, *Agonischius* Candeze, Elateridae, India.

Two new species of genus *Agonischius* Candeze are added to the six known species from India. These are *A. stripedius* and *A. piceus*. A key to the Indian species of *Agonischius* Candeze is provided.

INTRODUCTION

Genus *Agonischius* is a large group represented by 170 species, the majority of which belong to the Oriental region. Vats and Chauhan (1993) recorded 6 species from India, of which four were new species. We are adding two new Indian species to the known fauna of this genus. A key to the species from India is also provided.

Genus *Agonischius* consists of small to medium-sized beetles which are generally brilliant coloured, sometimes with metallic lustre. It is characterized by antennal segment 2 being very small; prothorax with centered margin deflected below the eyes; prosternopleural sutures double; metacoxal plates narrow with linear or emarginate inner margins, and parameres lacking subapical processes.

The type material will be deposited at Pusa National Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi, India.

KEY TO SPECIES OF *Agonischius* Candeze

1. Antenna extending beyond posterior pronotal angles ....:. 2
 Antenna at the most reaching posterior pronotal angles 5
2. Carinae of posterior pronotal angles equal in length .... *cinnamomeus* Candeze
 Carinae of posterior pronotal angles unequal in length 3
3. Pronotum bicoloured, black with two lateral ferruginous stripes; head as long as broad; elytra pointed at extremity .... *stripedius* sp. nov.
- Pronotum unicoloured, piceous or fuscous; head longer than broad; elytra rounded at extremity 4
4. Body fuscous; pronotum without depression; scutellum ferruginous with black margins; posterior angles pointed; elytra less than 3x prothorax length .... *chamoliensis* Vats & Chauhan
- Body piceous; pronotum with median longitudinal depression in its posterior 1/3; scutellum uniformly piceous; posterior angles rounded; elytra more than 3x prothorax length .... *piceus* sp. nov.
5. Elytra with metallic reflection; head broader than long 6
- Elytra without metallic reflection; head as long as broad 7
6. Elytra with blue reflection; head convex; prothorax black .... *cyanoreflexus* Vats & Chauhan
- Elytra with green reflection; head depressed; prothorax reddish with black longitudinal band .... *viridoreflexus* Vats & Chauhan
7. Carinae on posterior pronotal angles equal .... *suturalis* Candeze
- Carinae on posterior pronotal angles unequal .... *chauhani* Vats & Chauhan.

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Agonischius stripedius sp. nov.
(Figs. 1, 3, 6)

Colour: Body ferruginous, black are: extreme anterior margin, 1/5 of posterior margin, broad lateral margins and a broad medial longitudinal band of pronotum (Fig.3); scutellum; entire lower surface of body. Antenna fuscous.

Measurements: Body: length 12 mm, width 2.25 mm; head: length 1 mm, width 1 mm; antenna 4.25 mm; 2nd segment 0.1 mm; 3rd segment 0.45 mm; 4th segment 0.4 mm; last segment 0.5 mm; thorax: length 2.75 mm, width 2.25 mm; elytra 7.75 mm.

Structure: Body width less than 0.25x its length. Head subconvex, as long as broad; antenna extending beyond posterior angle of pronotum; segment 3 longer than 2 as 9:2 and also longer than 4 as 9:8. Pronotum (Fig.3) convex with median longitudinal glabrous line in its posterior half, longer than broad as 11:9, lateral margins parallel, posterior margin entire; posterior angles rounded, bicarinate, carina short, equal, not reaching middle of pronotum; prosternal spine rounded, declined from its main axis at 20°, emarginate, gradually narrowing at base. Metacoxal plate rounded at posterior margin (Fig.6). Scutellum flat, longer than broad as 2:1, anterior margin truncate, posterior margin arcuate. Elytra convex, 2.8x prothorax length, pointed at extremities; striae distinct. Metabasitarsus shorter than following 2 joints combined as 3:4.

Sculpture: Head with simple dense, large, hexagonal punctation; pronotum punctate like head; propleurae with simple, dense, small, hexagonal punctation; prosternum punctate like head; elytral striae deep, distinct, rounded punctation; interstriae with fine, sparse, inconspicuous punctation.

Pubescence: Body covered with simple, dense, slanting, whitish yellow pubescence.

Male genitalia: Fig.1. Phallobase with rounded anterior margin; parameres without subapical processes, posterior end rounded; aedeagus distinctly longer than parameres, medially slightly constricted, conical posteriorly; furcae very short, not reaching anterior margin of parameres.

Material examined: *Holotype:* Male, Meghalaya, Cherrapunji, 1470 m, 29.iv.1994, under light, Coll. V. Vasu. *Paratypes:* 1 female with same data as holotype. Nagaland, Singtam, 1500 m, 2 males 4.v.1995, under light, Coll. Punam.

Distribution: INDIA: Meghalaya, Nagaland.

Diagnostic combinations: Pronotum bicoloured (black with two ferruginous stripes), head as long as broad and elytra pointed at extremities are the characters which distinguish A. *stripedius* from the other species of this genus.

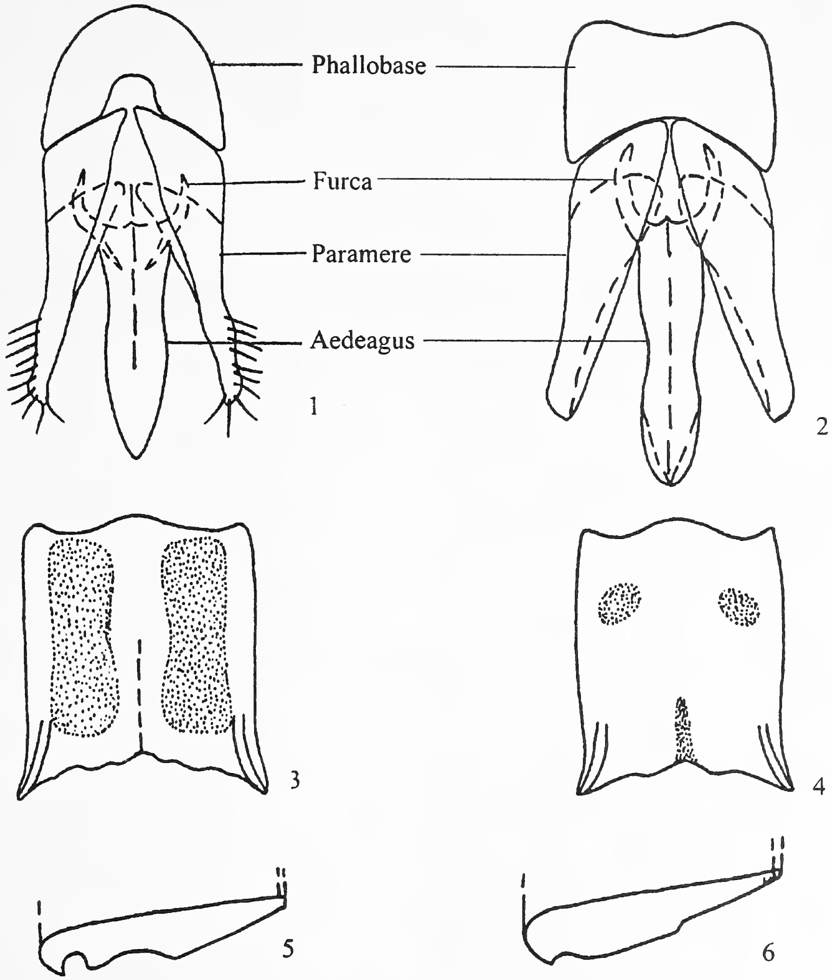
Etymology: The species name pertains to the black stripe on pronotum.

Agonischius piceus sp. nov.
(Figs. 2, 4, 5)

Colour: Body piceous including legs and antenna.

Measurements: Body: length 9.5 mm, width 1.8 mm; head: length 0.9 mm, width 0.7 mm; antenna 3 mm; 2nd segment 0.1 mm; 3rd segment 0.35 mm; 4th segment 0.25 mm; last segment 0.4 mm; thorax: length 2 mm, width 1.8 mm; elytra 6.25 mm.

Structure: Body width less than 0.25x its length. Head flat, longer than broad as 9:7; antenna extending beyond posterior angle of pronotum; segment 3 longer than 2 as 7:2 and also longer than 4 as 7:5. Mandible dentate. Pronotum (Fig. 4) convex with median longitudinal shallow depression in its posterior one-third and a shallow, oval fovea one on each side of median line, longer than broad as 10:9, lateral margins subconvex; posterior angles long, rounded, bicarinate, carinae equal, short, not reaching middle of pronotum; prosternal spine rounded, declined from its main axis at 35°, gradually narrowing at base. Metasternum truncate between mesocoxae. Metacoxal plate angular at posterior margin (Fig. 5). Scutellum



Figs. 1-2. Lancet: 1. *Agonischius stripedius,* 2. *A. piceus;* Figs. 3-4. Pronotum: 3. *A. stripedius,* 4. *A. piceus;* Figs. 5-6. Metacoxal plate: 5. *A. piceus,* 6. *A. stripedius.*

flat, longer than broad as 3:2, anterior margin rounded, posterior margin arcuate. Elytra convex, 3.12x prothorax length, rounded at extremities; striae distinct. Metabasitarsus shorter than following 2 joints combined as 5:6.

Sculpture: Head with simple, dense, small, hexagonal punctation; pronotum and propleurae punctate like head; prosternum with simple, moderate, small, rounded punctation; elytral striae with deep, distinct, small, oval punctation; interstriae with sparse, fine, inconspicuous punctation.

Pubescence: Body covered with simple, dense, slanting, brownish yellow pubescence.

Male genitalia: Fig. 2. Phallobase with concave anterior margin; parameres without subapical processes, with posterior ends rounded; aedeagus distinctly longer than parameres, tubular, uniformly thick with rounded tip except slight medial constriction; furcae short, not

reaching anterior margin of parameres.

Material examined: *Holotype:* Male, Manipur, Ukhrul, 1700 m, 15.vi.1994, ex. forest vegetation, Coll. V. Vasu. *Paratypes:* 1 female, same data as holotype; 1 male, 1 female, Nagaland, Satakha, 1500 m, 12.v.1994, under light, Coll. Punam.

Distribution: INDIA: Manipur, Nagaland.

Diagnostic combinations: *A. piceus* is distinguished from *A. chamoliensis* by: body piceous (fuscous in latter), pronotum medially depressed (not depressed in latter), posterior angles rounded (pointed in latter) and elytra more than 3x prothorax length (less than 3x in latter).

Etymology: Species name pertains to body colour.

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■ ■ ■

A NEW SPECIES OF *POA* L., FAMILY POACEAE FROM GARHWAL HIMALAYA, INDIA[1]

D.C. Nautiyal and R.D. Gaur[2]

(*With one text-figure*)

Key words: *Poa garhwalensis* sp. nov. *Poa gammieana,* Garhwal, Himalaya

Plant explorations in the Garhwal Himalaya yielded a new species *Poa garhwalensis* Nautiyal et Gaur. sp. nov. This was collected at the Indo-Tibetan border of Chamoli district. It comes close to *Poa gammieana* Hook. f.

During the recent plant explorations in the remote localities of Garhwal Himalaya, we collected some interesting specimens of the genus *Poa* from an alpine zone, Leptal, at the Indo-Tibetan border of Chamoli dist. Critical analysis and comparison of these specimens with the literature as well as material from the Herbaria of Botanical Survey of India (BSD), and Forest Research Institute (DD), Dehra Dun, distinctly warranted a new species, which has been described hereunder.

Poa garhwalensis Nautiyal et Gaur sp. nov.

Haec species *Poa gammieana* Hook. f. affinis, a qua differt habitu minus foliaceo, cum internodis 1 vel 2, ligulis brevioribus, 1.5-3 mm longis, panicula laxa, ramis inferioribus 3-5, scabridis, spiculis ellipticis, 5-11 mm longis, cum flosculis 3-7(8), rhachilla breviore, 0.5-0.8 mm longa, lemma acuto, 4-4.5 mm longo, paleae carinis scabridis, anthera longiore, 2-2.5 mm longa.

Typus: Northwest Himalaya, Leptal (4000m), August 4, 1996. Coll. D.C. Nautiyal, Holotypus GUH: 13501A; Isotypus 13501B.

This species is allied to *P. gammieana* Hook. f., and a comparison of both the species is given in Table 1 with a description of the new taxon.

Perennial tufted grass; culms erect, 45-60x0.3 cm, partly terete, smooth; nodes 2. Leaf blade linear, acute, 4-10x0.2-0.3 cm, scabrid on both surfaces as well as margins; sheaths keeled, 10-20 cm long; ligules ovate-obtuse, 1.5-3 mm long. Panicles lax, 4-10x3-4 cm; branches spreading, axis cylindrical, scabrid, lower branches 3-5, scabrid; pedicels scabrid; spikelets elliptic, 5-11 mm long, 3-8 flowered, pale-green or purplish. Lower glumes oblong, acute, 3-3.2 mm long, 3-nerved, margins hyaline, surface glabrous, keel scabrid on upper part; upper glumes narrowly oblong, 3.2-3.8 mm long, 3-nerved, margins hyaline, surface glabrous, keel scabrid above. Rhachilla 0.5-0.8 mm long, scabrid. Callus with ciliate hairs. Lowest lemma oblong, acute, 4-4.5 mm long, 5-nerved, surface scabrid

Table 1

COMPARISON OF THE KEY FEATURES OF *POA GAMMIEANA* AND *P. GARHWALENSIS*

Poa gammieana Hook. f.	*P. garhwalensis* sp. nov.
1. Culms leafy throughout with 7-8 internodes.	1. Culms with 2-3 leaves and 1-2 internodes.
2. Ligules oblong-acute, 3.5-4 mm long.	2. Ligules ovate-obtuse, 1.5-3 mm long.
3. Panicles narrowly spreading; lower branches 2, smooth.	3. Panicles loosely spreading; lower branches 3-5, scabrid.
4. Spikelets oblong-lanceolate, 5.5-9.2 mm long, 3-4 flowered.	4. Spikelets elliptic, 5-11 mm long, 3-8 flowered.
5. Margins of glumes hardly hyaline; palea keels semipilose.	5. Margins of glumes hyaline; palea keels almost scabrid.
6. Anthers 1.1-2 mm long.	6. Anthers 2-2.5 mm long.

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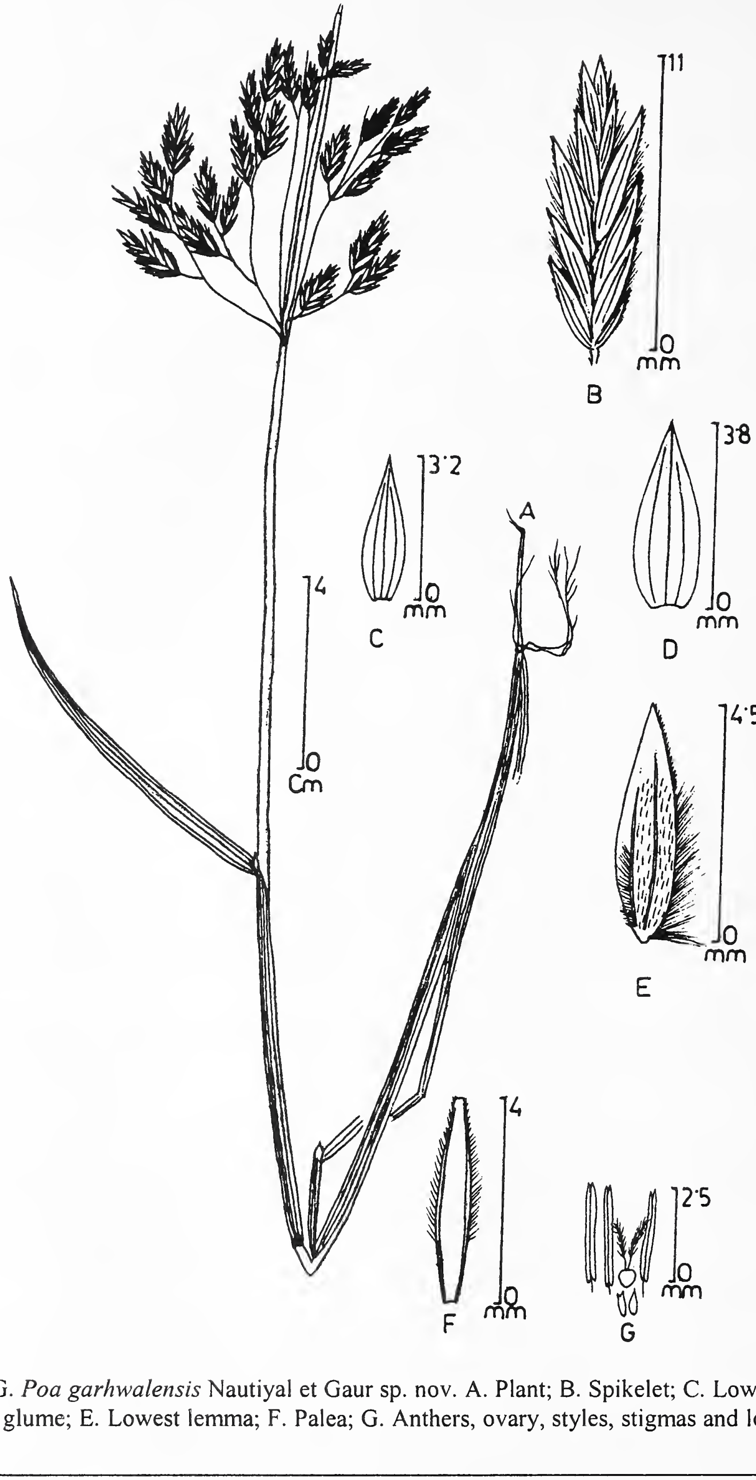

Fig. 1: A-G. *Poa garhwalensis* Nautiyal et Gaur sp. nov. A. Plant; B. Spikelet; C. Lower glume; D. Upper glume; E. Lowest lemma; F. Palea; G. Anthers, ovary, styles, stigmas and lodicules.

except hyaline tip, margins hyaline, keel ciliate on lower two-thirds, scabrid above, marginal nerves ciliate on lower half. Paleas elliptic-oblong, 3.2-4 mm long, keels almost scabrid. Stamens 3; anthers 2-2.5 mm long. Ovary with distinct styles and stigmas. Lodicules 2, 0.5-0.8 mm long. (Figs. 1A-G).

Fl. & Fr.: Aug.-Oct.

Habitat: In marshy alpine meadows.

ACKNOWLEDGEMENTS

We thank the Botanical Survey of India, Northern Circle, Dehra Dun and Forest Research Institute, Dehra Dun for Herbarium and Library facilities; Dr. N.C. Majumdar for Latin diagnosis of the taxon and the Council of Scientific and Industrial Research (CSIR), for financial assistance.

■ ■ ■

NOEMACHEILUS MENONI, A NEW SPECIES OF FISH FROM MALAPPARA, PERIYAR TIGER RESERVE, KERALA[1]

V.J. ZACHARIAS[2] AND K.C. MINIMOL[3]

(*With one text-figure*)

Key words: *Noemacheilus menoni* sp. nov., Western Ghats, Periyar

Noemacheilus menoni is described as a new species of fish from the Periyar river of the High Ranges of the Western Ghats of Kerala State, South India, from five specimens. It is characterised by a complete lateral line, an irregular reticulation of dark blotches and bands with light or creamy inter-spaces on the body, and three narrow bands on the caudal fin.

INTRODUCTION

This genus consists of a group of species which are remarkably similar in general morphology. Environmental conditions tend to produce similar characters and it is probable that the great resemblance between the various species of this genus is due to a similarity in their environment. The usual environment of rapid running water of these loaches is full of stress and the animals that live in such a habitat have to adjust constantly to any fluctuation in the microclimate. Their body has become more and more cylindrical, with the fins becoming smaller and compact to facilitate their living amongst pebbles and shingle in swift running water (Menon, 1987).

In addition to the new species described here, the following five species are recognised from the Periyar River: (1) *Noemacheilus denisoni denisoni* Day (2) *Noemacheilus keralensis* (Rita & Nalbant), (3) *Noemacheilus triangularis* Day. (4) *Noemacheilus guentheri* Day and (5) *Noemacheilus evezardi* Day.

In the course of our studies on the fishes of Periyar river in Kerala State, South India, five specimens were obtained which are distinct from other species described so far. They are described here as a new species.

MATERIAL AND METHODS

The material examined in this study consists of 5 specimens measuring 46 to 54.4 mm SL collected from the fast flowing Periyar at Malappara about 17 km above the Periyar Lake, between 9° 16' and 9° 40' N lat. and between 76° 55' and 77° 25' long. The description is based on measurements with dial calipers. Data are presented as percentages of standard length (SL) and head length (HL), with the range followed by the mean in parentheses. One example, not included in the present study has been deposited with ZSI, Madras.

Noemacheilus menoni sp. nov. (Fig. 1)

Diagnosis: A species of *Noemacheilus* having 8 branched rays in the dorsal fin, lateral line complete, 3 pairs of barbels, and dorsal and caudal fins with dark spots (Fig. 1).

Holotype: ZSI Calicut V/F/1018, 54.4 mm SL. Collected from Malappara in Periyar river on March 2, 1997 by the authors.

Paratypes: 4 specimens ZSI, Calicut V/F/1019, 46-49 mm SL. Same data as holotype. One specimen deposited at ZSI, Madras. No. F. 5255 ZSI/SRS collected from the same locality in February 1996.

Description: Based on 5 specimens.

D.3/8, A.2/5, P.1/11, V.1/6/1, C.19 Lateral line complete.

Body cylindrical, eyes small, nostrils close to each other, anterior tubular. Mouth semicircular. Barbels well developed. Dorsal fin inserted almost equidistant between tip of snout and caudal fin base. Caudal fin forked.

Depth body 12.2-14.5 (M = 13.16) % SL, length of head 19.5-23.9 (M=21.52) %, snout

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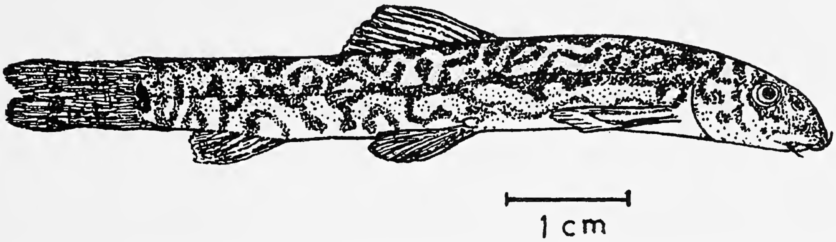

Fig. 1: Lateral view of *Noemacheilus menoni*, sp. nov.

length 7.3-8.6 (M=7.96) % SL, 32.7-41.6 (M=37.24) % HL. Eye shorter than snout, its diameter 9.9-17.7 (M=13.8) % HL and 38.4-56.6 (M=47.5) % inter-orbital width. 2 pairs of barbels are shorter than eye, its length 8.4-14.5 (M=12.2%) % HL second pair of rostral barbels are longer than eye, its length 20-26.7 (M=22.32) % HL, Maxillary barbels are almost equal to second pair of rostral barbels, its length 20-26.7 (M=22.94) % HL.

Caudal peduncle length 12.2-14.5 (M=12.94) %, its least height 40.0-50.0 (M=44.86) % HL, 71.4-76.6 (M=74.28) % of its own length.

Squamation: Lateral line complete, well distinguishable up to end of base of anal fin. Scales small and imbricate except on ventral side of body.

Fins: Dorsal origin between tip of snout and base of caudal, its height less than length of head, 14.2-15.8 (14.88) % SL, height of anal fin 49.1-60 (M=54.34) % HL. Pectoral fin smaller than head, length of pectoral 16.3-18.7 (M=17.12)% SL. Pelvic fin smaller than head and pectoral fin, its length 12.5-14.5 (M=13.54) % SL. Caudal fin forked, longer than head, lobes somewhat pointed, predorsal distance 49.3-52.9 (M=51.34) % SL. Pre-pelvic distance 48.8-54.1 (M=51.62) % SL; distance between origin of pectoral and pelvic fins 22.9-33.0 (M=27.9) % SL, pelvic to anal distance 23.7-25.7 (M=24.62) % SL.

Coloration: Body with irregular dark blotches on back, sides marked by irregular reticulation of dark blotches and wavy bands with light or creamy interspaces; blotches and bands being more prominent on the upper half. Dorsal and caudal fins have three narrow bands each, anal and pelvic have one each; caudal fin has a black blotch at its base.

Distribution: The Periyar River at Malappara, Kerala, South India.

Remarks: More than 450 species are described under *Noemacheilus* (Kottelat, 1982). These species are quite varied and diverse, and form several recognisable groups or subgenera. These fishes inhabit hill streams and are restricted to South China, Southeast Asia, Baluchistan, Western Iran, South Anatolia and Lake Tsana in N.E. Africa.

The species *N. menoni* described here appears to be closely related to *N. triangularis* Day occurring in the Western Ghats of Kerala (Kallar, Periyar, Pamba and Bharatapuzha drainage) and Tamil Nadu (Thambraparni drainage). Both have 8 branched rays in the dorsal fin, slightly tubular anterior nostrils without nasal barbels, forked caudal and an irregular pattern of dark bands, bars or blotches characteristic of the subgenus *Mesonoemacheilus*. However, the new species can be separated from *N. triangularis* by the irregular reticulation of dark blotches and wavy bands with light or creamy interspaces as against the six or seven oblique yellow bands edged with black of *N. triangularis*. *N. guentheri* Day, another related species, can be separated by the 2 or 3 rows of large yellow spots edged with black on its body.

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■ ■ ■

A NEW SISORID CATFISH OF THE GENUS *MYERSGLANIS* HORA & SILAS 1951, FROM MANIPUR, INDIA[1]

WAIKHOM VISHWANATH AND LAISHRAM KOSYGIN[2]

(*With one plate and one text-figure*)

Key words: Catfish, Sisoridae, *Myersglanis jayarami* sp. nov., Manipur

A new freshwater sisorid catfish, *Myersglanis jayarami* is described here based on eight specimens collected from Laniye river (Chindwin drainage) of Manipur, India. It is characterised by a band of transverse teeth in the upper jaw which is slightly indented in the middle anteriorly, and conical and pointed teeth in the jaws. The species is also distinct in having 10 branched pectoral rays, 5 branched anal rays, 15-16 branched caudal rays and an adipose dorsal fin confluent with caudal fin. A key to the species of genus *Myersglanis* is also given.

INTRODUCTION

Day (1869) described *Exostoma blythi* without mentioning its type locality. The species was assigned to the genus *Glyptosternum* McClelland by Hora (1923) and to *Euchiloglanis* Regan by Norman (1925). Hora and Silas (1951) proposed a new genus *Myersglanis* to accommodate Day's species as it had characters distinct from species of other glyptosternoid genera. *Myersglanis* is distinct in having conical and pointed teeth on both the jaws, a transverse band of teeth in the upper jaw which is not produced backwards at the sides, and continuous lower labial fold. Other characters include a dorso-ventrally flattened body with laterally compressed caudal peduncle, gill openings restricted to the dorsal surface, weak dorsal spine, lunate caudal fin, first ray of paired fins corrugated ventrally in pinnate folds for adhesive purpose and absence of thoracic adhesive apparatus. This peculiar monotypic genus occurs only in Nepal (Misra, 1976; Jayaram, 1979; Talwar and Jhingran, 1991). Recently, one of us (L. Kosygin) collected eight specimens of *Myersglanis* during an investigation of hill stream fishes in Ukhrul dist., Manipur, India. They differ from *M. blythi* in many respects. The fish is described here as a new species.

The specimens were fixed and preserved in 10% formalin. Measurements and counts followed Jayaram (1981). All measurements were made with a calliper to the nearest 0.1 mm. The type specimens of the new species have been deposited in the Manipur University Museum of Fishes (MUMF).

Abbreviations: ASB, Asiatic Society of Bengal; ZSI, Zoological Survey of India, Calcutta; SL, standard length; HL, head length; SD, standard deviation; M, mean.

Myersglanis jayarami sp. nov.

Material examined: *Holotype*: 82.0 mm SL, Regn. No. MUMF 2138, Locality: Laniye river at Jessami, Manipur, India (94° 32' E, 25° 38' N), Coll. L. Kosygin, 15.viii.1994.

Paratypes: 7 exs., 54.0-75.0 mm SL, Regn. No. MUMF 2105, 2139-2144, collection data same as holotype.

Diagnosis: *Myersglanis jayarami* sp. nov. is easily distinguished from its only congener *M. blythi* in having less branched pectoral rays (10 against 16-17); more branched caudal rays (15-16 against 13); anal fin origin equidistant

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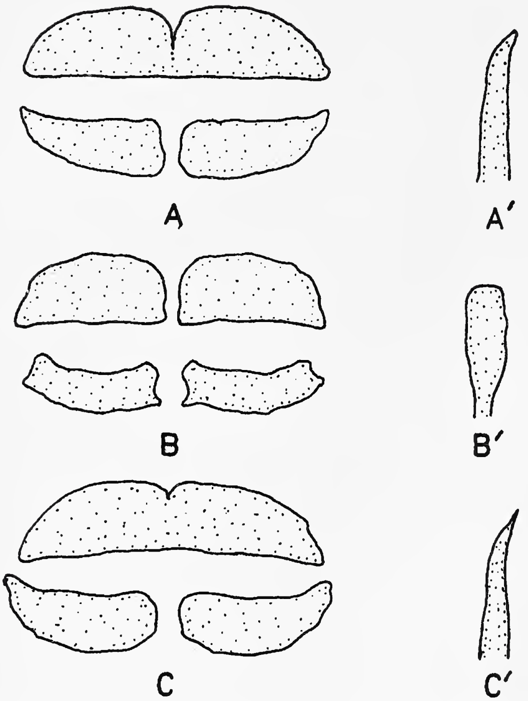

Fig. 3: Nature of teeth band along with shape of tooth: *Myersglanis jayarami* (A, A'), *Exostoma vinciguerrae* (B, B') *Euchiloglanis sinensis* (C, C')

from pelvic fin origin and caudal fin base (against nearer caudal base) and also in having an adipose dorsal fin which is confluent with caudal fin.

Description

The lateral view of the fish is shown in Plate 1, Fig. 1. Morphometric data of holotype and 7 paratypes are given in Table 1. Head and body depressed. Ventral surface flattened from snout to vent, caudal peduncle laterally compressed, its depth 59.4 - 69.2% its length (M= 63.1; SD=3.4). Head broad, width 88.9-100.0 % HL (M= 94.7; SD= 4.1), height at occiput 48.1-68.3% HL (M=59.2; SD=4.9). Eye very small, subcutaneous, not visible from ventral surface, almost in the middle of HL, diameter 8.4 - 10% HL (M=9.3; SD=0.5). Snout obtuse, length 44.4-49.7 % HL (M= 47.3; SD= 1.9).

Table 1

MORPHOMETRIC DATA OF *MYERSGLANIS JAYARAMI* SP. NOV. HOLOTYPE (MUMF 2138) AND 7 PARATYPES (MUMF 2105, 2139-2144)

	Holotype	Holotype & Paratypes		
		Range	Mean	SD
Standard Length (mm)	82.0	54.5-82.0	-	-
In % SL:				
Head length	20.1	20.1-23.8	22.1	1.2
Body depth	15.2	12.9-17.7	16.3	1.6
Head height at occiput	11.6	11.2-14.7	13.1	1.2
Head height at orbit	9.7	9.5-12.0	10.5	0.6
Head width	20.1	19.2-22.0	20.9	0.9
Snout length	9.7	9.7-11.1	10.4	0.3
Eye diameter	1.8	1.8-2.4	2.1	0.2
Inter-orbital space	5.5	5.2-7.3	6.2	0.7
Internasal space	4.3	4.3-5.3	4.8	0.4
Mouth width	7.9	7.9-9.0	8.5	0.4
Caudal peduncle length	20.7	19.0-21.8	20.3	0.9
Caudal peduncle height	12.8	11.5-14.0	12.8	0.9
Dorsal fin height	15.2	14.3-16.7	15.6	0.7
Adipose dorsal fin length	31.7	27.2-34.3	31.4	2.1
Adipose dorsal fin height	2.4	1.5-3.0	2.4	0.5
Pectoral fin length	17.7	16.8-19.3	18.3	0.8
Pelvic fin length	15.8	15.3-16.7	16.0	0.6
Anal fin height	12.8	12.2-14.7	13.6	0.9
Upper Caudal fin lobe length	17.1	16.0-17.5	16.8	0.6
Lower Caudal fin lobe length	18.3	17.2-19.3	18.1	0.8
Distance between snout tip &:				
Dorsal fin insertion	39.0	37.4-42.1	39.8	1.6
Pectoral fin insertion	15.2	14.5-17.2	15.7	0.9
Pelvic fin insertion	44.5	44.5-47.4	46.4	1.0
Anal fin insertion	73.2	73.2-75.2	74.0	0.7
Vent	67.1	67.1-69.5	68.2	0.9
Posterior margin of lower labial fold	7.8	7.8-10.0	9.3	0.8
Inter-dorsal space	19.3	18.4-25.3	20.9	2.3
Ventral fin to anal fin origins	26.4	25.7-27.5	26.8	0.9
Anal fin origin to caudal base	27.8	25.2-27.5	26.5	0.6
Maxillary barbel length	16.5	16.3-19.3	17.6	1.1
Nasal barbel length	8.5	8.4-10.5	9.1	0.7
Outer mandibular barbel length	6.7	6.1-8.8	7.2	0.8
Inner mandibular barbel length	2.4	2.3-3.5	2.8	0.4

Vishwanath, Waikhom *et al.*: *Myersglanis jayarami* PLATE 1

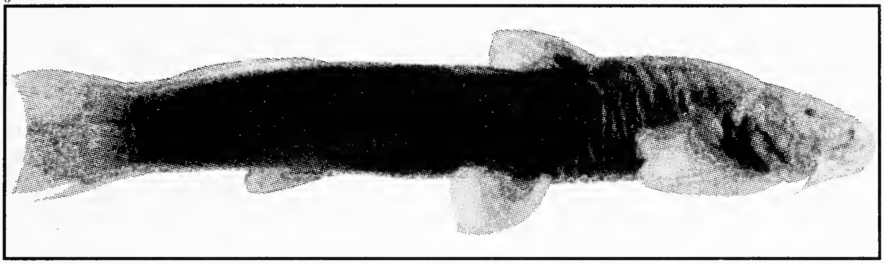

Fig. 1: Lateral view of *Myersglanis jayarami* sp. nov.
(Holotype, 82.0 mm Standard length)

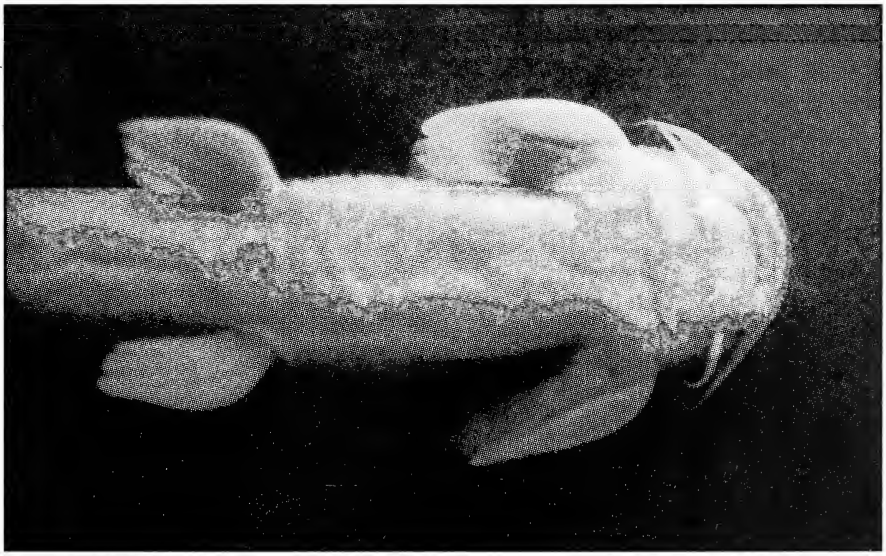

Fig. 2: Ventral view of *Myersglanis jayarami*

Mouth inferior, transverse, surrounded by fleshy lips, width 34-41% HL (M=38.5; SD= 2.0). Lower labial fold continuous. Teeth conical, pointed and directed backwards in both jaws. The band of teeth in the upper jaw slightly indented in the middle and not produced backwards at the sides (a comparison of shape of teeth and teeth bands of *Myersglanis jayarami* and other Glyptosternoid fishes is shown in Fig 3). However, the bands are not separated into two as in *Exostoma* Blyth. Teeth band in lower jaw is divided in the centre and pointed towards the sides. Plate edentulous. Gill openings dorso-lateral, extending only to the opposite base of the pectoral spine. Barbels 4 pairs, maxillary barbels with broad base and its ventral surface provided with pinnate folds. It extends to one-third of the length of pectoral fin base. Nasal barbels exceed posterior margin of orbit, outer mandibular barbels just reaching pectoral fin origin. Inner mandibular barbel very short. Chest transversely striated on the sides, gradually becoming posteriorly directed skin folds on the extremities (Plate 1, Fig. 2).

Rayed dorsal without strong spine. It has one simple and 6 branched rays. Its origin lies nearer to snout tip than to caudal base. Adipose dorsal fin low, long and confluent with caudal fin. Paired fins are broad, rounded, their inner half vertical and outer half horizontal in position. The first ray of paired fins flattened and ventrally corrugated in pinnate folds. Pectoral fin with one simple and 10 branched rays. Pelvic fin with one simple and 5 branched rays. Pectoral and pelvic fins are separated by a considerable distance. Anal fin with one simple and 5 branched rays. Its origin lies equidistant from pelvic fin origin and caudal fin base. Caudal fin lunate, lower lobe slightly longer than the upper with 15-16 branched rays. Lateral line distinct. Skin soft and smooth.

Colour of live specimen: Yellowish grey to dingy olive brown with pale white ventral surface. Head, dorsal streak and lateral line darker; caudal fin dusky.

Distribution: Lainye river at Jessami, Manipur (Chindwin drainage), India.

Etymology: The new species is named after Dr. K.C. Jayaram who encouraged us in this work and provided relevant literature.

Discussion

Hora and Silas (1951) classified Glyptosternoid fishes based on the nature of teeth and form of teeth bands in the jaws. They considered the nature of the fold of lower lip also as a generic character apart from dentition. The new species has all the characteristic features of the genus *Myersglanis*, i.e., the presence of (i) all conical and pointed teeth in both jaws, (ii) a continuous teeth band in the upper jaw, and (iii) a continuous lower labial fold.

The species described here is similar to *Euchiloglanis* Regan, in the shape of teeth and nature of teeth bands. However, it differs in having a continuous lower labial fold compared to the widely interrupted fold of the latter. Hora and Silas (*op. cit.*) considered this a major character in distinguishing the two genera. The new species has a continuous lower labial fold as in *Exostoma* Blyth. But *Exostoma* is distinct in having oar-shaped teeth and two clearly separated upper teeth bands.

With this report, the genus *Myersglanis* is no more monotypic and its range of distribution extends up to Manipur, India (Chindwin drainage).

Comparative materials: *Myersglanis blythi*: ASB Cat. F 599 in ZSI, 2 ex., 55.0-57.5 mm SL, Pharping, Nepal, Coll. F. Day, no date. *Euchiloglanis kamengensis*: ZSI F 2106/2, 2 ex., *Paratype*, Norgum river, Kalaktang Kameng Frontier Division, NEFA, Coll. K.C. Jayaram, 22.iii.1961. *Exostoma vinciguerrae* - ZSI F6667/1, ZSI F6671/1, 2 exs, 34.0-37.5 mm SL, Pazi, Moughong, N. Shan States, Myanmar. Coll. J. Coggin Brown, no date, MUMF 2356, 4 ex., 50.6-76.7 mm SL, Adaiki stream, Manipur, Coll. M.G. Sharma, no date; *E. berdmorei,* ASB cat

597, type, 64 mm SL., Tenasserim, Myanmar, Coll. Maj. Berdmore, no date. *E. stuarti,* Holotype, 44 mm SL, ZSI F 9742/1, Putao plains, Tanja, Tibetan Frontier, Myanmar, Coll. Dr. Murray Stuart, no date.

Key to species of genus *Myersglanis* Hora & Silas

Pectoral fin with 16-17 branched rays; Caudal fin with 13 branched rays .... *Myersglanis blythi*

Pectoral fin with 10 branched rays, Caudal fin with 15-16 branched rays .... *M. jayarami*

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NEW SPECIES OF *ACACIMENUS* DLABOLA (HEMIPTERA: CICADELLIDAE: DELTOCEPHALINAE) FROM INDIA AND SRI LANKA[1]

C.A. VIRAKTAMATH[2]

(*With thirty-one text-figures*)

Key words: *Acacimenus* Dlabola, Cicadellidae, new species, India, Sri Lanka.

Genus *Acacimenus* Dlabola has been recorded for the first time from the Oriental region. Five new species of this genus, namely *Acacimenus deccanensis* sp. nov., *A. maheshai* sp. nov., *A. inequalis* sp. nov., *A. variabilis* sp. nov. (all from India) and *A. zeylonicus* sp. nov. (from Sri Lanka) are described and illustrated. Their relationships with *A. makranus* Dlabola, the type species of the genus from the Palaearctic region, are discussed. A key to the species of this genus is also provided.

INTRODUCTION

Dlabola (1979) described the genus *Acacimenus* from specimens collected from Iran, Saudi Arabia and Baluchistan, feeding on a species of *Acacia* (Fabaceae) with *Acacimenus makranus* Dlabola as the type species. The forewing of this species is similar to that of *Hishimonus* Ishihara, and vertex similar to that of *Neoaliturus* Distant and *Opsius* Fieber.

During field trips in India for the survey of leafhoppers associated with sandal forests (Subba Rao *et al.,* 1988), the author discovered a number of specimens resembling species of *Orosius* Distant in coloration breeding on species of *Acacia* (especially *A. leucophloea*). On closer examination, they were found to represent four new species of *Acacimenus*. Another new species of this genus from Sri Lanka was also discovered from the collections of the U.S. National Museum of Natural History, Washington, D.C. All five of these species are described here as new to science.

The holotypes of the new taxa (except *A. zeylonicus*) have been deposited in the University of Agricultural Sciences, GKVK, Bangalore (UAS). The paratypes are to be deposited in the Natural History Museum, London, U.K. (BMNH), National Pusa Collection, Indian Agricultural Research Institute, New Delhi (NPC) and the U.S. National Museum of Natural History, Washington D.C. (USNM).

Genus *Acacimenus* Dlabola

Acacimenus Dlabola, 1979; 137. Type species: *Acacimenus makranus* Dlabola, by original designation.

In general, all species of *Acacimenus* are very distinctly coloured with brown irroration on ivory background; second antennal segment chocolate brown; legs with broad (but variable) brown to chocolate brown patches, the patch on apex of hind tibia always consistent; coloration often similar to that of the various species of *Orosius*; forewings with a medial discal spot as in *Hishimonus* and *Naevus* Knight; head, thorax and scutellum shagreened; vertex slightly more elongated medially than next to eyes, anteriorly rounded to face; ocelli placed at a distance equal to their own diameter from adjacent eye; a cross vein between claval veins and between outer claval vein and claval suture; inner anteapical cell closed behind.

Male pygofer with caudal margin concavely excavated dorsally, with more anterior margin produced into a sclerotized knob, the caudal point rounded; subgenital plates triangular with an oblique row of setae; connective Y-shaped with bifid stem; style robust

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with claw-like apophysis having sculptured surface; aedeagus with a well developed, often plate-like dorsal apodeme, shaft with apical and subapical processes variously branched; gonopore apical. Seventh sternum of female rectangular with the hind margin produced into a small lobe posteriorly.

Remarks: Though *Acacimenus* resembles some of the genera of the tribe Opsiini such as *Hishimonus, Neoaliturus, Opsius* and *Orosius,* it can be readily recognised by its single aedeagal shaft while all others have paired shafts.

Pruthi (1934) described *Orosius santali* Pruthi from a sandal forest in south India (Tamil Nadu: North Salem, Jawalagiri) which in the author's opinion also belongs to this genus. However, the type specimens of the species are missing from the Zoological Survey of India collection and hence it is difficult to recognise this species.

1. ***Acacimenus maheshai*** sp. nov.
(Fig. 1-6)

Coloration as in *A. makranus,* but darker; mesal border of gena near lorum whitish.

Male genitalia: Pygofer with dorsal margin produced into a short, digitate process, caudal margin dorsally concave, ventral margin slightly convex; long setae dorsally confined to the caudal region, ventral area uniformly clothed with microsetae; valve triangular, subgenital plate triangular with a series of stout setae arranged in an oblique row, connective and style as in generic diagnosis; aedeagal shaft cylindrical, uniformly curved, with a pair of subapical ventrolaterally directed processes, each process with three rami near its base; gonopore apical; dorsal apodeme half as long as shaft.

Female genitalia: Seventh sternum rectangular with a short, bilobed, median projection on hind margin.

Measurements: Male 3.5 (3.4-3.7) mm long, 1.1 (1.0-1.2) mm wide across eyes. Female 4.1 (3.9-4.4) mm long, 1.3 (1.2-1.4) mm wide across eyes.

Material examined: **Holotype**: male, INDIA: Karnataka: Sulikere (near Bangalore), 30.xii.1976, Coll. C.A. Viraktamath (UAS). **Paratypes**: INDIA: Karnataka: 1 male, data as in holotype; 3 females, 8 km S. Dharwar, 1.ix.1972, Coll. C.A. Viraktamath; 1 male, 7 km N. Dodballapur, 18.vi.1977, Coll. C.A. Viraktamath; 1 female, 20 km NW Dodballapur, 18.vi.1977, Coll. C.A. Viraktamath; 1 male, 8 km E. Channapatna, 15.vii.1977, Coll. C.A. Viraktamath; 2 males, Bidar, 14.ix.1984, Coll. Shashidhar (BMNH, NPC, UAS, USNM).

Remarks: *A. maheshai* is related to *A. makranus* but differs from it in having branched aedeagal process and cylindrical rather than compressed aedeagal shaft.

Etymology: Named after Lord Shiva.

2. ***Acacimenus inequalis*** sp. nov.
(Figs. 7-12)

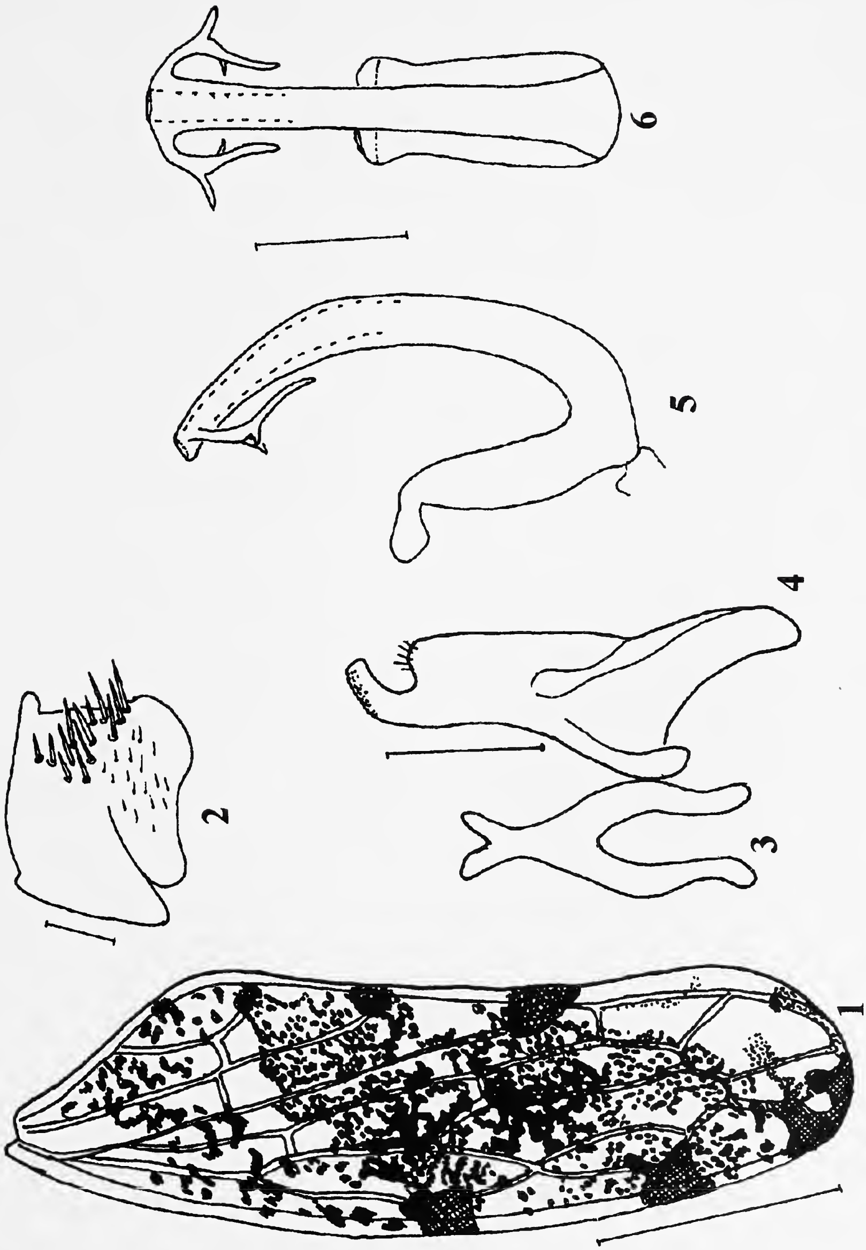
Coloration as in *A. variabilis* sp. nov. but more richly spotted with brown.

Male genitalia: Similar to those in *A. maheshai.* Body of style with a strong lateral excavation at the middle (arrowed in Fig. 9); aedeagal shaft with a pair of short prong-like processes at the anterior margin and with a pair of longer, forked lateral processes; dorsal apodeme slightly less than 0.5 times as long as shaft.

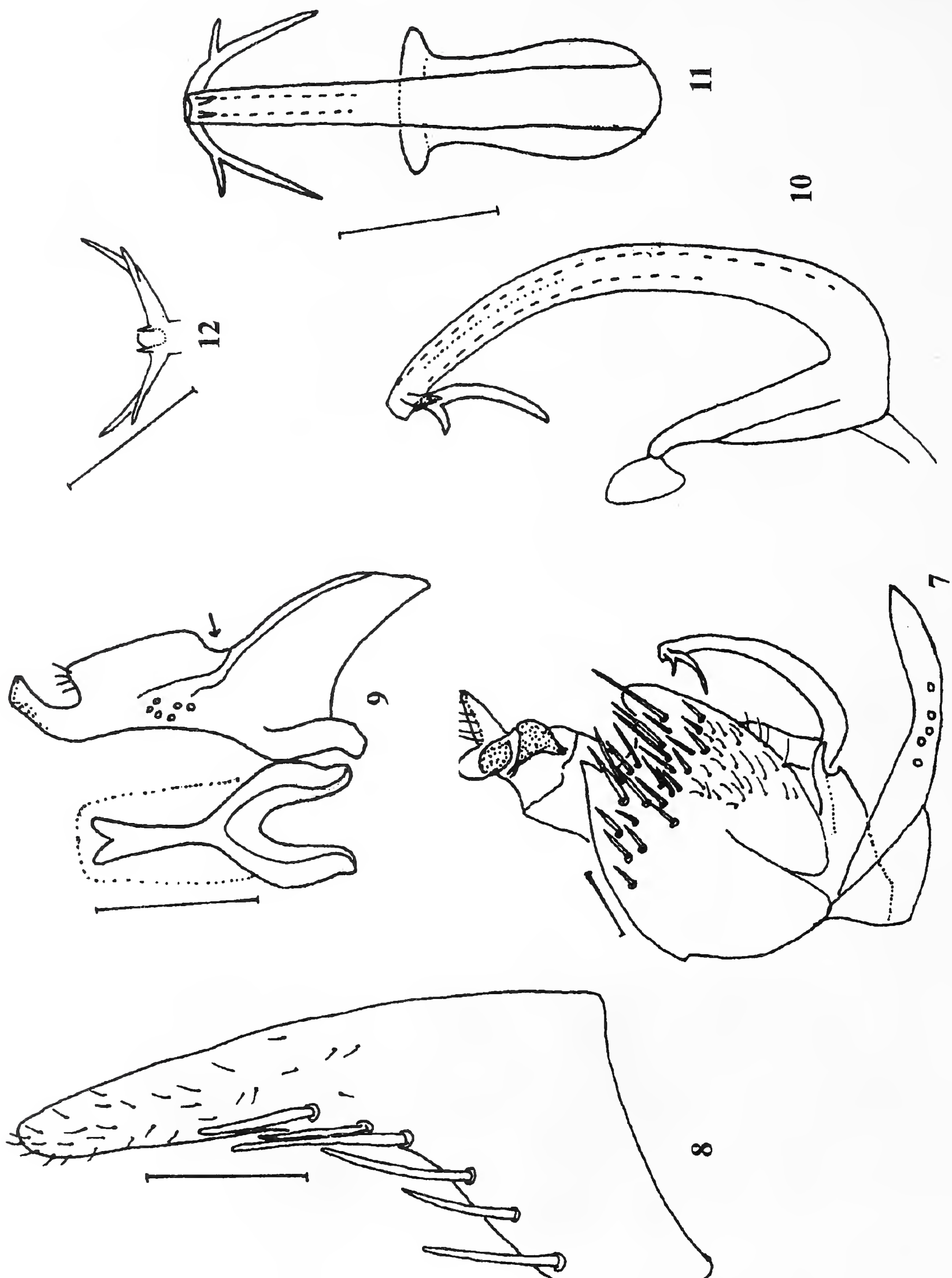
Measurements: Male 3.3 mm long, 1.1 mm wide across eyes. Female 3.8 mm long, 1.1-1.2 mm wide across eyes.

Material examined: **Holotype**: male, INDIA: Gujarat: Ahmedabad, 27.i.1981, Coll. C.A. Viraktamath (UAS). **Paratypes**: 2 males and 3 females, data as for holotype (BMNH, NPC, UAS, USNM).

Remarks: This species can be recognised at once by the pair of prong-like processes on the anterior margin of the aedeagal shaft. It is related to *A. maheshai* and *A. variabilis*, and differs from both of them in the manner of branching of the processes of the aedeagal shaft.



Figs. 1-6: *Acacimenus maheshai* sp. nov.: 1. Forewing; 2. Pygofer, lateral view; 3. Connective; 4. Style; 5. Aedeagus, lateral view; 6. Aedeagus, caudal view. Scale line in Fig 1 = 1 mm; Figs. 2-6 = 0.1 mm



Figs. 7-12: *Acacimenus inequalis* sp. nov.: 7. Male genitalia, lateral view; 8. Subgenital plate; 9. Connective and style; 10. Aedeagus, lateral view; 11. Aedeagus caudal view; 12. Apex of aedeagal shaft, ventral view. Scale line equals 0.1 mm.

Etymology: The species name alludes to the unequal processes of the aedeagal shaft.

3. ***Acacimenus variabilis*** sp. nov. (Figs. 13-21)

Coloration similar to that of *A. maheshai* but paler; brown markings on forewing less extensive.

Male genitalia: Similar to that in *A. maheshai;* aedeagus more robust, process of aedeagal shaft with a basal fork, the shorter being unbranched and the longer process variably branched.

Female genitalia: Similar to that of *A. maheshai.*

Measurements: Male 3.9 (3.8-4.0) mm long, 1.2 (1.1-1.2) wide across eyes. Female 4.2 (3.8-4.6) mm long, 1.3 (1.2-1.4) mm wide across eyes.

Material examined: **Holotype**: male, INDIA: Karnataka: Bangalore, 916 m, GKVK, 30.iv.1976, Coll. C.A. Viraktamath, ex. Sandal (UAS). **Paratypes**: INDIA: Karnataka: 1 male data as in holotype; 4 males, 4 females, data as in holotype but collected on 15.x.1978; 1 female, Bidadi, 28.x.1976, Coll. B. Mallik; 1 female, Chikballapur, 17.iii.1977; 1 male, 5 km S. Kolar, 12.iv.1977; 1 male, Devanahalli, 9.vi.1977; 2 males, 2 females, 7 km N. Dodballapur, 18.vi.1977; 1 female, 8 km E. Channapatna, 15.vii.1977; 1 male, Kollegal, 8.viii.1977; 1 male, 18 km E. Chamarajanagar, 13.viii.1977; 1 male, Hubli, 16.xi.1977; 4 males, 2 females, 10 km N. Hunsur, 16.i.1978; 1 female, 10 km N. Nagarhole, 16.i.1978, all collected by C.A. Viraktamath (BMNH, NPC, UAS, USNM). Other material: 1 female, 8 km S. Dharwar, Navalur Hill, 1.ix.1972; 1 female, Dharwar, x.1969, at light, Coll. C.A. Viraktamath (UAS).

Remarks: *A. variabilis* is the palest among the species of *Acacimenus* and has highly variable branched processes of the aedeagal shaft. It is closely related to *A. maheshai* and *A. inequalis* in having similar cylindrical aedeagal shaft, but can be differentiated by the aedeagal shaft process which is branched at the base instead of a short distance away from the base as in *A. maheshai.* From *A. inequalis* it is distinguished by the absence of short projections on anterior margin of aedeagal shaft near apex, which are present in *A. inequalis.*

Etymology: The species name alludes to the variable nature of branching of the aedeagal processes.

4. ***Acacimenus deccanensis*** sp. nov. (Figs. 22-24)

Coloration similar to that of *A. maheshai,* but the forewing has more numerous dark brown spots.

Male genitalia: Similar to that of *A. maheshai.* Aedeagus compressed along the distal half, in lateral view broadest near apex, shaft with two pairs of processes, more apical process directed anterio-laterally, robust, entire except bifid apex, more basal process slender, deeply forked, more dorsal process longer than the ventral one.

Measurements: Male 3.4 mm long, 1.1 mm wide across eyes.

Material examined: **Holotype**: male, INDIA: Karnataka: Gulbarga, 25.xi.1981, Coll. A.R.V. Kumar (UAS).

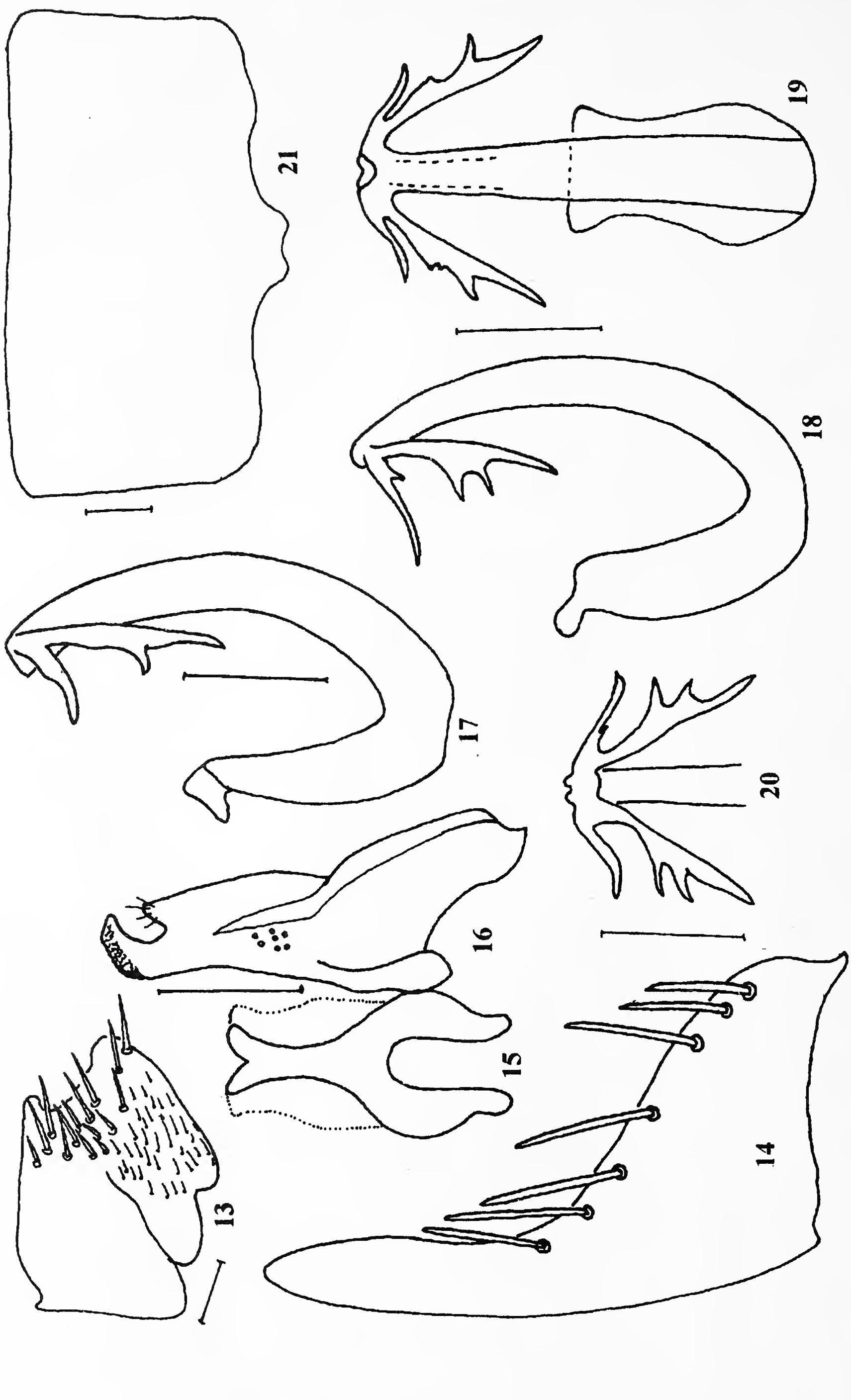
Remarks: Considering the compressed aedeagal shaft, *A. deccanensis* appears to be related to *A. makranus,* but differs from it in having two pairs of aedeagal processes. It, however, appears to be more closely related to *A. zeylonicus* than to *A. makranus.*

Etymology: The species name alludes to the type locality i.e. Deccan plateau of peninsular India.

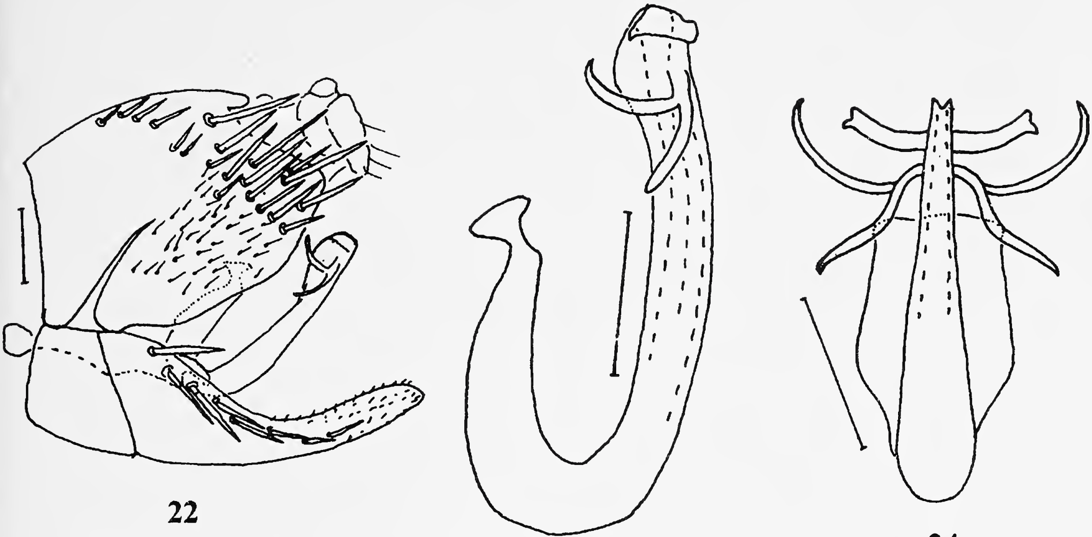
5. ***Acacimenus zeylonicus*** sp. nov. (Fig. 25-31)

Coloration as in *A. makranus* but paler.

Male genitalia: Male genitalia similar to that of *A. maheshai.* Apophysis of style digitate, much less curved than in any of the Indian species; stem of the connective broader, caudal margin entire; aedeagal shaft widest at the middle



Figs. 13-21: *Acacimenus variabilis* sp. nov.: 13. Pygofer; 14. Subgenital plate; 15. Connective; 16. Style; 17, 18. Variation in the Aedeagus, lateral aspect; 19. Aedeagus, caudal view; 20. Apex of aedeagus, caudal view; 21. Female seventh sternum. Scale line equals 0.1 mm.



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Figs. 22-24: *Acacimenus deccanensis* sp. nov.: 22. Male genitalia, lateral view; 23. Aedeagus, lateral view; 24. Aedeagus caudal view. Scale line equals 0.1 mm.

with two pairs of processes, one apically forked pair arising near apex and the second unforked pair arising at 0.6 length of the shaft.

Female genitalia: Seventh sternum rectangular, with the hind margin having a median semicircular lobe.

Measurements: Male 3.5 (3.4-3.6) mm long, 1.2 mm wide across eyes. Female 3.8 mm long, 1.2 mm wide across eyes.

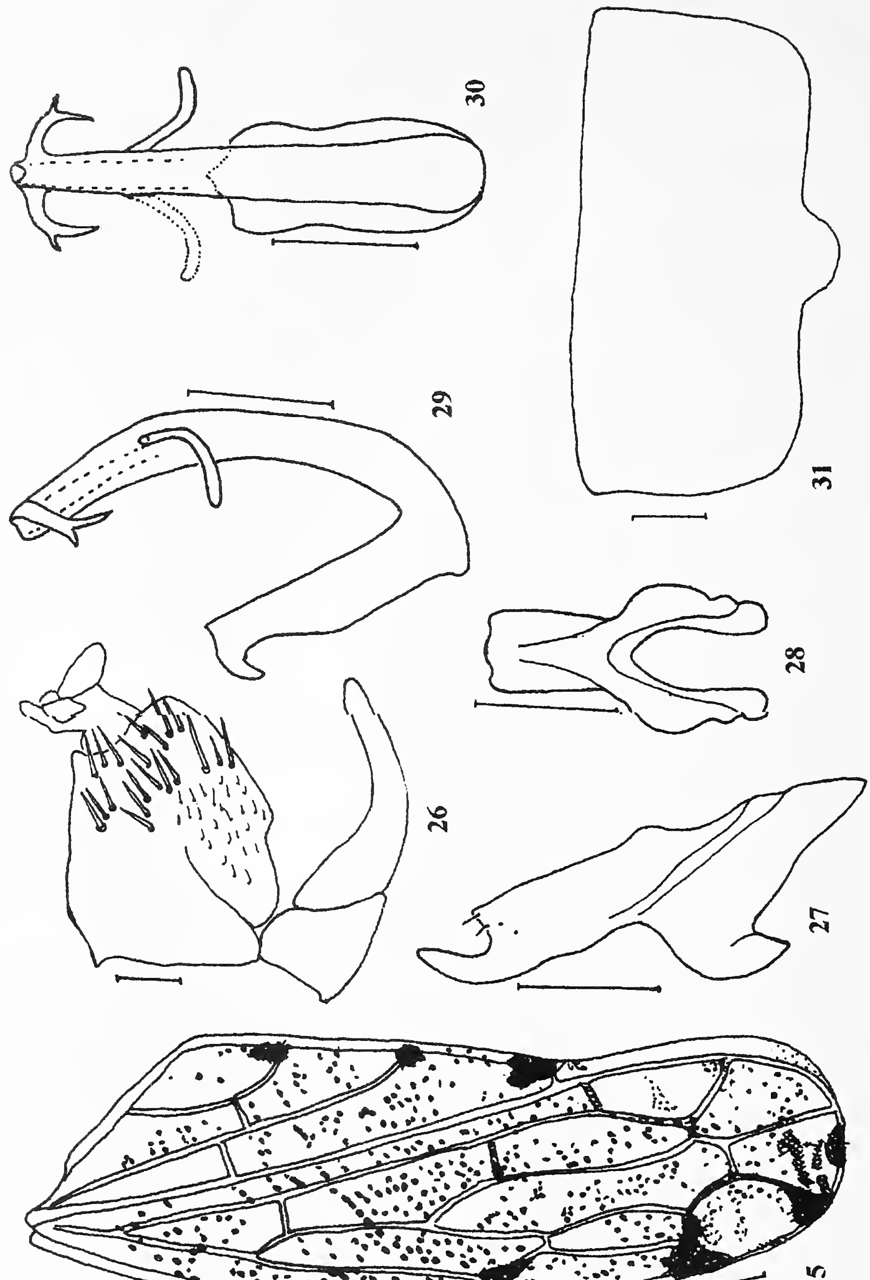
Material examined: **Holotype**: male, Sri Lanka: Anu. Dist., Hunuwilagama, 28 Oct.-3 Nov.1976, Coll. G.F. Havel, R.E. Dietz IV, S. Karunaratne, D.W. Balasooriya (USNM). **Paratypes**: 4 males, 1 female, data as for holotype (USNM).

Remarks: *A. zeylonicus* is not closely related to any of the known species of *Acacimenus*. It differs from the Indian species by the shape of the apophysis of the style, connective, the more basal process of the aedeagus arising at 0.6 distance from the base of the shaft and the median lobe-like projection on hind margin of the female seventh sternum being rounded rather than bilobed as in *A. maheshai* and *A. inequalis*.

Etymology: From the country (Ceylon) where the type was collected.

KEY TO THE SPECIES OF *Acacimenus* Dlabola

1. Aedeagus with a pair of short projections on anterior margin of shaft near apex, in addition to long processes (Figs. 10, 11) .... *A. inequalis* sp. nov.
- Aedeagus not as above 2
2. Aedeagus with one pair of processes to shaft (Figs. 5, 6, 17, 18) 3
- Aedeagus with two pairs of processes (Figs. 23, 24, 29, 30) 5
3. Processes of aedeagus almost 0.75 as long as shaft, unbranched, with a triangular expansion on the distal half .... *A. makranus* Dlabola
- Process of aedeagus less than 0.5 as long as shaft, variously branched (Figs. 6, 19) 4
4. Aedeagal shaft process forked at base, longer fork in turn variously branched (Figs. 17-20) .... *A. variabilis* sp. nov.
- Aedeagal shaft process forked a short distance away from base, with three forks (Figs. 5-6) .... *A. maheshai* sp. nov.



Figs. 25-31: *Acacimenus zeylonicus* sp. nov.: 25. Fore wing; 26. Male pygofer, valve and subgenital plate, lateral view; 27. Style; 28. Connective; 29. Aedeagus, lateral view; 30. Aedeagus, caudal view; 31. Female seventh sternum. Scale line in Fig. 25 equals 1 mm, in Figs. 26-31 equals 0.1 mm.

5. Aedeagal shaft processes arising close together, more basal process forked (Figs. 23, 24) .... *A. deccanensis* sp. nov.
- Aedeagal shaft processes wide apart; more basal process unbranched (Figs. 29-30) .... *zeylonicus* sp. nov.

ACKNOWLEDGEMENTS

I thank Dr. V.V. Belavadi, Department of Entomology, Regional Research Station, Mudigere for translating Dr. Jiri Dlabola's paper and Dr. R.C. Froeschner, USNM, Washington D.C. for loan of material for the present study.

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REVIEWS

1. PEOPLE AND PROTECTED AREAS: TOWARDS PARTICIPATORY CONSERVATION IN INDIA. Editors Ashish Kothari, Neena Singh, Saloni Suri. First published 1996. pp. 276, (14.5 x 22 cm). Sage Publications, New Delhi. Hard bound Edition Rs. 350/-.

The book is a compilation of papers presented at the workshop on 'Exploring the Possibilities of Joint Management of Protected Areas in India', held in New Delhi in September, 1994. At the outset, the organisers rightly acknowledge that 'India's enormous diversity of wild plants and animals will not survive for long in the absence of public support'. They note that 'though conservation policies have succeeded to some extent in stemming the environmental destruction being caused by rampant industrial and urban growth, unfortunately they have also created enemies of the very people who have historically been the strongest conservationists: traditional forest and wetland dependent communities'.

The organisers aver that the elitist (*sic*) conservation programmes, which are the root cause of alienating these communities, should be re-examined and such communities are empowered to become equal partners in conservation. The contributions in the book suggest ways and means to bring about this change which, the protagonists acknowledge, cannot be brought about overnight.

Human-wildlife conflicts have become one of the most serious threats faced by our protected areas. It is argued that a protection strategy which alienates local communities is unjust to them and disrespectful of their fundamental rights, as also shortsighted for wildlife conservation. The book examines the problems and possible solutions from different perspectives, including Policy and Legal Aspects, Institutional and Procedural Aspects, and Proposals for Joint Management. The book also contains a chapter on 'Experiences from other Countries and lessons for India'.

The contributors who include activists, forest officials, scholars and wildlife experts have focussed on the country's Protected Area Network which, in recent times, has also witnessed bitter conflicts between local communities and the authorities entrusted with the task of protecting the network, which comprises just about 4% of the country's land mass. It is unfortunate indeed that attention is now focussed — for all the wrong reasons — on a minuscule portion of the country's land mass, inspite of the other 96% being available for all the 'development' activities. The conflicts in a few cases have also been the result of activists itching for a fight in the garb of 'ecologists'. It has become a fad for people to propound the cause of systems which they understand little, but pretend to know all! Unfortunately, most of the issues, instead of being tackled at a pragmatic level, are clouded by emotive views and the resultant decisions are also less than efficient and pragmatic. The book is recommended as a first step towards familiarising oneself with the two sides of a story which is inexorably heading towards tragedy, unless saner counsel prevails. But at Rs 350/- it is exhorbitantly priced, and defeats the very purpose of creating public awareness by making such publications more easily and cheaply available.

■ S. ASAD AKHTAR

2. AMPHIBIANS OF INDIA AND SRI LANKA by Sushil K. Dutta. Odyssey Publishing House, 1999. pp. 342 + xxii, (21.5 x 14 cm). Hard bound. Price not mentioned.

The taxonomy of Amphibians, which had been somewhat uneasily stable for the major part of this century, entered a period of frenetic change in the eighties. Generic names, which had been

traditionally considered as more or less stable, were changed and species groups listed under a single genus scattered under a spate of new genera, as old generic names were revived and new names created for species which were under subgenera and were given generic status.

It is with something of a sigh of relief that one receives Sushil Dutta's efforts to bring stability to a chaotic situation. In this book Dutta provides a checklist of the Amphibians of India and Sri Lanka. The two sections of this book are complementary. The first section lists the names which were commonly in use for species occurring in India and Sri Lanka and their current equivalents.

In the second section the 'species account' describes the synonymy, distribution, notes on systematics, suggests further reading and lists the species examined by Dutta in the various museums of the world.

It is in this section that one questions the labelling of specimens even in reputed museums. For instance, Madras is given as a locality for a specimen of *Ichthyophis beddomii,* a species which prefers high rainfall mountainous habitat. Similarly, Okha in Gujarat is a locality for *Indotyphlus battersbyii,* a most unlikely habitat, being a dry, seashore village. Surely there is scope to re-examine type localities and distribution of species as related to their habitat requirements. Incidentally, spelling errors in the generic name of *Indotyphlus* on page 33 need attention.

A most valuable section of the book is its exhaustive Bibliography, a boon to those working on Indian Amphibia. However, correlation between the bibliography and species list needs to be checked.

A very commendable effort and recommended as the checklist for Indian Amphibia. It will continue to be the standard reference till the relationships of Indian amphibians are tested by DNA studies and we achieve a stable taxonomy. One wishes the book's binding had received more attention.

■ J.C. DANIEL

3. BIRDS OF THE INDIAN SUBCONTINENT by Richard Grimmett, Carol Inskipp, and Tim Inskipp. Christopher Helm of A & C Black Ltd, London, 1998. pp. 888, 153 colour plates, (24.5 x 16.5 cms). ISBN 0-7136-4004-9. Price £55.00

This is indeed a *magum opus,* covering 1,295 bird species, all of India, the Andaman and Nicobar Islands, Pakistan, Sri Lanka, Nepal, Bhutan, and the Maldives, and in a literal sense weighing just over 2.17 kg.

Everyone interested, is aware of the huge advances in recent decades both in field craft skills in ornithology and representational skills by wildlife artists, and this volume epitomises these advances, drawing as it does on 12 top bird illustrators, and the specialised knowledge in the field of more than 33 experts (cited in the acknowledgements) with special knowledge of different bird families, or regions.

For those already familiar with earlier books on the region, the sequence of bird families and choice of English names may be a little bit confusing, as the authors follow Sibley and Monroe's cladistic taxonomic sequence, and in taxonomic nomenclature, follow the Oriental Bird Club's ANNOTATED CHECKLIST OF THE BIRDS OF THE ORIENTAL REGION. Both these sources will undoubtedly be more and more widely used and followed, and the exhaustive index should obviate any difficulty in locating information on a specific bird. It would be impossible to comment on the contribution of so many individuals, but suffice it to say that the Inskipps are already well known to readers from their books on Nepal and published surveys in adjoining regions, whilst Richard Grimmett, with extensive field experience in the Oriental Region, and an accomplished bird artist himself, was the first

President of the Oriental Bird Club, which has lead directly to such prolific cross fertilisation of knowledge and ideas about the region covered. To this reviewer, the great strength of the illustrations lies in the artists' abilities to convey 'jiz' for the different families. For example, Craig Robson who did the plates for the Timalidae is undoubtedly the acknowledged expert on this family, with vast field experience extending throughout southeast Asia, all too apparent in the quality of the many colourful plates of Laughing Thrushes, Wren Babblers etc.

With such a growing body of information on difficult identification problems, plumage variations, and newly separated sibling species, there is going to come a time when the concept of a Field Guide, brief and portable in the field, as opposed to a lengthy and weighty Handbook, are no longer distinguishable. Where do we go from here? No doubt the serious student will answer that ownership of several different books is the ideal solution, but this mouth watering book, by virtue of the quality and comprehensiveness of its illustrations, and its multiauthorship very nearly fulfills both roles and summarises much information already published to date.

Other reviewers have already criticised the distribution maps, with very pale shading used for seasonal distribution, which are impossible to evaluate without use of a magnifying glass, even for a sharp eyed birdwatcher! It would be easy to point out other minor discrepancies which do not detract from the enormous care and accuracy of the whole. For example, the Headquarters of WWF Pakistan has always been in Lahore, currently with 133 professional staff, not in Peshawar. Having photographed the Tibetan snowcock in the wild (Nepal), it has a striking belly pattern with vertical thin dark stripes, not diagonal stripes, often missed as in this case (Plate 1), when painting from museum skins, because the incision down the mid-belly often results in slight displacement of the feather alignment. The fieldfare, *Turdus iliacus,* has now been reliably recorded from the NWFP in Pakistan, and its wing deposited some years ago with the BNHS collection.

The authors are to be congratulated on producing such a comprehensive volume, which is worth every bit of its price!

■ TOM ROBERTS

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MISCELLANEOUS NOTES

1. STATUS OF PAINTED BAT *KERIVOULA PICTA* (PALLAS 1767) IN MAHARASHTRA

Recently, a painted bat *Kerivoula picta* obtained at Dahanu was received at the Society. Dahanu, situated north of Maharashtra (19.15°-20.08° N, 72.32°-73.08° E) is almost on the border of Maharashtra and Gujarat and it is likely that this species is also found in Gujarat from where there is no record as yet.

The painted bat *Kerivoula picta* is widely but patchily distributed in India (Bates and Harrison, 1997). In Maharashtra, so far there are only two old published records, Mumbai (Blandford, 1889-91); Ghatmatha (Wroughton, 1916). Very little is known about their current status in Maharashtra. Bates and Harrison (1997) gave their conservation status as "widely distributed, but appear to be rare". Recently, a freshly collected specimen obtained at Dahanu (Maharashtra) was brought to the Society. It was skinned and added to the collection (Regn. No. 18366). Our (BNHS) collection has another specimen (Regn. No. 18365) obtained by Mr. Prashant Mahajan at the Conservation Education Centre, Goregaon (East), Mumbai. The bat, a male, was attracted to light and died in the building premises. Another specimen (Regn. No. 17670) was collected by Ms. Ferreira on May 4, 1967 at Gorai (Borivli), Mumbai.

Ramachandran and Jayson (1994) recorded a pair of painted bats, female carrying a young one, brought to the Kerala Forest Research Institute on August 26, 1993. The bats were captured from a banana plantation at Kanara, Trichur dist., Kerala State.

The Dahanu specimen is also a male but is smaller in size and is possibly a subadult.

The external measurements (in mm) are as follows:

	Regn. No. 18366	Regn. No. 18365
HB	32.45	36.55
T	35.40	32.40
FA	22.85	23.60
E	13.10	14.70

HB: head and body length - from the tip of the snout to the base of the tail.

T: tail length - from the tip of the tail to its base adjacent to the body.

FA: forearm - from the extremity of the elbow to the extremity of the carpus.

E: ear from the lower border of the external auditory meatus to the tip of the pinna, not including any tuft of hair.

March 5, 1999

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2. PANGOLIN SIGHTINGS IN WESTERN ARUNACHAL PRADESH

During field work from November 1995 to April 1996 for a project in Pakhui Wildlife Sanctuary (92°7.5'E - 92°22'E and 26°53.7'N - 27°16.2'N), East Kameng dist., western Arunachal Pradesh, I sighted pangolins on two occasions. Both sightings were in the daytime. The first sighting was in 1995 in a reserve forest near Balijuri in Sonitpur dist. Assam (near the Assam-Arunachal border). The animal was moving in the vegetation near the roadside. The second sighting was of an animal foraging near a perennial stream (locally called Sukan nala) in the early morning around 8 am in December 1997. It was observed digging near the edge of the stream, but vanished into the undergrowth on my approach.

Two species of pangolins occur in India, viz. the Indian pangolin *(Manis crassicaudata)* and the Chinese pangolin *(Manis pentadactyla)*. The distribution of the Indian pangolin is given as being in peninsular India, south of the Himalaya and in Sri Lanka, while that of the Chinese pangolin is through northeastern India, Nepal, Burma and south China (Grzimek 1975, Prater 1980, Corbet and Hill 1992). The Chinese pangolin is somewhat smaller in size than the Indian pangolin and has 15-18 rows of scales around the body, while the Indian pangolin has 11-13 scales around the body (Prater 1980, Corbet & Hill 1992). Other than these differences, there seem to be no field characters by which the two species can be distinguished, though Grzimek (1975) points out that the scales of the Chinese pangolin are blackish-brown, while those of the Indian pangolin are large and light yellow-brown. The animals I saw were light brown in colour, but given the fact that the distribution of the Indian pangolin is in peninsular India, the animal I saw is probably the Chinese pangolin. This species is rarely sighted or recorded as it is nocturnal. The Chinese pangolin is listed in Schedule 1 of the Wildlife (Protection) Act, 1972. It would be interesting to know if there is any overlap in the range of the two species.

June 29, 1998

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3. SIGHTING OF RUSTYSPOTTED CAT *PRIONAILURUS RUBIGINOSUS* IN TADOBA ANDHARI TIGER RESERVE, MAHARASHTRA

The rustyspotted cat was once thought to be rare with a small range of distribution. It has since been reported from Gir Wildlife Sanctuary (Chellam, pers. comm.), Kuno Wildlife Sanctuary (Vidya Athreya and Christy Williams pers. comm.) and Melghat Tiger Reserve (Wankhede, 1996). Acharjyo *et al.* 1997, reported the presence of this lesser cat from Phulbani dist. in Orissa for the first time. In 1994, it was reported from Sariska Tiger Reserve (Mukharjee, pers.

TABLE 1
MORPHOMETRIC MEASUREMENTS OF THE SPECIMEN FROM BOTEJHARI VILLAGE

Body Parts	Measurements (cm)
Total Body Length	54.5
Length of Hind Legs	14.00
Length of Fore Legs	10.5
Tail Length	17.5
Length of Skull	6.8
Length of Whiskers	3.5
Length of Upper jaw = 3.8 cm	Length of lower jaw = 4.5 cm
Canine length = 0.8 cm	Canine length = 0.6 cm
Dental configuration = $\frac{\text{I C P M}}{3\ 1\ 1\ 1}$	Dental configuration = $\frac{\text{I C P M}}{3\ 1\ 1\ 2}$

comm.) and one dead specimen was reported from Udaipur (Raza, 1994). It has also been reported from Anaimalai hills in Western Ghats (Mudappa pers. comm.) and Central Kerala (Kumar, pers. comm). During my field work from April 1994 to July 1997, this lesser cat was seen thrice (twice dead and once alive), in Tadoba Andhari Tiger Reserve in Maharashtra.

On April 24, 1995, a dead specimen of this cat was found at a distance of 800 m from Botejhari village inside the Tiger Reserve. Some morphometric measurements were taken from this specimen (Table 1). Dental configuration and measurement of jaws were also recorded (Table 1). In the upper jaw, the molars were fused together. Upper canines were longer than the lower canines.

On June 13, 1995, one individual was sighted. This sighting was also close to human habitation, 1.2 km from the village of Jamni. On January 18, 1996 another dead specimen was found close to a village, Moharli inside the Tiger Reserve.

It is interesting to note that all the sightings of dead and live individuals were very close to human habitation. Still not much is known about the status of this lesser cat.

May 3, 1999

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4. THE GAUR *BOS GAURUS* IN DIBANG VALLEY DISTRICT OF ARUNACHAL PRADESH

(*With a text figure*)

The gaur *Bos gaurus* H. Smith is a very poorly documented species in northeastern India, although it is widely distributed in the region. Except for a survey in north Bengal (Bhattacharyya *et al.*, 1997) no specific work of any significance solely for this bovine has been taken up in the region. I report here of the past and present status of the species in the entire Dibang Valley dist., (27°59'-29°29'N, 95°13'-96°36' E), Arunachal Pradesh as ascertained during field visits between 1992 and 1994. Dibang Valley dist. covers part of Mishmi Hills

as well as the plains of the Dibang river.

Till the early 1970s, the gaur was widespread all over the foothills and lower areas of Dibang Valley dist. starting from above Nizamghat to the inter-state border with Assam, mostly in the forests in the foothills and plains, and *chapori* (riverine islets and tracts) of the Dibang, Deopani and the Sesseri rivers. From the late 1970s, new settlements have started to come up in many of the plain areas, especially between Roing and Santipur, and in Bomjir and Bijari, destroying the forest areas. Gradually, the logging increased in the foothills also and the number of timber-based industries has also increased in places like Roing, Bijari, Bomjir, Bolung and other areas. These factors, along with local growth of population have resulted in degradation and alteration of the habitat. Easy availability of fire arms has resulted in increase in poaching for meat as the local tribes, both the Adis and Idu Mishmi, relish it. The gaur population has declined drastically.

At present, small populations occur in the lower areas of Mehao Wildlife Sanctuary, foothills above Dambuk, the lowland forest and grassland in Dibang Reserved Forest (RF), and Sirkee proposed RF. From Dibang RF, a few move down to Amarpur area of Sadiya in Tinsukia dist. (Assam), especially in winter (Choudhury, 1994, 1998). However, this movement has become irregular due to clearing of grassland for agriculture in Amarpur area. It may be mentioned here that part of Amarpur was inside Dibru-Saikhowa Wildlife Sanctuary till 1995 (excluded at the time of final notification). In Dibang Valley dist., the gaur occurs as far north as 28°30'N (approx.), which is also the northernmost limit of the world distribution of the species.

It is difficult to make an accurate population estimate as the animals are extremely shy due to regular persecution and are rather thinly distributed. However, after visiting all the known and potential areas and interviewing local hunters, graziers of the *khutis* and other tribal villagers, it can be generally estimated that there are less than 70 gaurs in the eastern areas of the Dibang river, mostly in Mehao Wildlife Sanctuary. In Dibang RF and in the foothills towards north and west of Dambuk, 30 to 60 animals occur. The total habitat available for the species in the district is more than 250 sq. km (Fig.1).

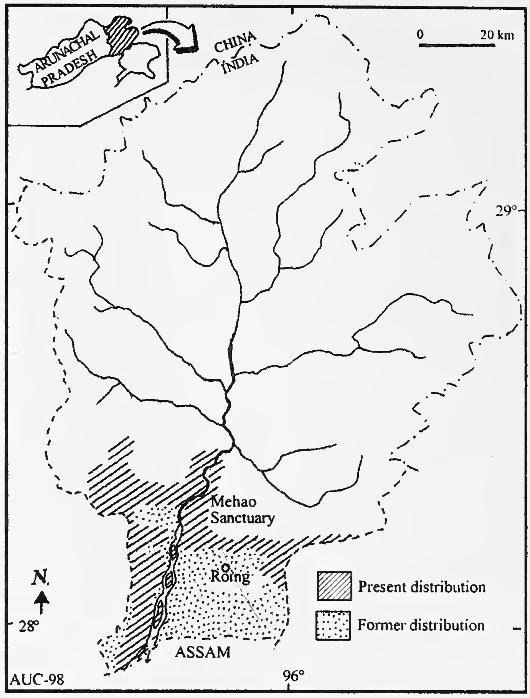

Fig. 1: Distribution of gaur in Dibang Valley dist.

The presence of domestic buffaloes in the *khutis*, especially in the lower reaches of the Dibang river, poses problems like the potential danger of spread of diseases like anthrax, foot and mouth and rinderpest.

While habitat destruction continues to be a threat, it is poaching with guns and rifles that is taking its toll on the gaurs and unless conservation measures are taken, the future of these animals is bleak. Parts of Dibang RF, Kerim RF and Sirkee proposed RF (totalling 202 sq. km.) have been recommended for a national park

for its importance as the habitat of the Bengal florican *Eupodotis bengalensis*, white-winged wood duck *Cairina scutulata*, tiger *Panthera tigris*, elephant *Elephas maximus*, wild buffalo *Bubalus arnee* and as an important flyway of migratory waterfowl including the common crane *Grus grus* (Choudhury, 1996). This proposed protected area, along with the existing Mehao Wildlife Sanctuary, will help protect the majority of the gaur population of Dibang Valley. The protection measures in Mehao, however, need to be strengthened as they are inadequate at present.

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5. LESSER FRIGATE BIRD, *FREGATA MINOR ALDABRENSIS* MATHEWS ON THE KERALA COAST

The lesser frigate bird breeds on the Indian Ocean Island, Aldabra (10° S lat. 45° E long. approx.) and on Seychelles (5° S lat. 55° E long). It is reported as a rare straggler during the monsoon in India (Ali and Ripley, 1968 HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Vol. I p. 48). The BNHS collection has a male bird, collected on 24.vi.1927 by L.A. Lampard, from Quilon, Kerala. There are two female specimens from Sri Lanka, one in the Colombo Museum and the other in the British Museum.

In 1982, one specimen was received by BNHS from S.N. College, Quilon, Kerala for identification; its photographs are available at BNHS. It seems to be a sub-adult, the dorsal side full black and the ventral side, throat and breast white like the female, but with a broad black band across the chest.

On August 9, 1997 one bird was collected (found exhausted, died later) from Kannur in Kerala by C. Sashikumar and sent to BNHS. It is an adult female.

Measurement of the specimens in mm:

	Wing	Bill from feathers	Middle toe	Tail
Male	520	100.5	50, 50.5	388
	(IH 585-603	116-130	48-57	392-410)
Female	620	110	52.5, 53.5	435
	(IH 605-621	130-150	48-57	395-430)

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6. POND HERON IN PIN VALLEY NATIONAL PARK, SPITI, HIMACHAL PRADESH

The Indian pond heron or paddy bird (*Ardeola grayii grayii* Sykes) has been recorded up to an altitude of 2150 m in the Nilgiris, and to about 1500 m in Kashmir and Nepal (Ali and

Ripley 1983). This species did not figure among the 93 confirmed species and 4 probable species that Koelz (1937) recorded for the entire Spiti area.

We wish to record an altitudinal extension of this species, one individual of which was observed in August 1995, at an altitude of 4050 m, in Pin Valley National Park, in the Trans-Himalayan Spiti region of Himachal Pradesh. The bird was seen in the vicinity of a riverine patch of willow (*Salix* sp.) in the Chohyam area of the National Park. Local people also did not recollect having seen such a bird before. The species is not a migrant, and it is therefore improbable that it landed in the area *en route*.

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7. THE PAINTED SPURFOWL *GALLOPERDIX LUNULATA* VALENCIENNES IN RANTHAMBHORE NATIONAL PARK, RAJASTHAN

In the *JBNHS* Vol. 93 No. 1, there is mention by Shantanu Kumar on the occurrence of the painted spurfowl in the Ramgarh Sanctuary of Bundi dist., Rajasthan, and by Ashok Kumar Sharma on the occurrence of this bird in the Jamwa Ramgarh Sanctuary in Jaipur dist., as also in the Ranthambhore National Park and its adjacent sanctuaries.

I have also watched a pair of painted spurfowl at close quarters and was able to take a number of photographs of them in the Ranthambhore National Park in 1989. However, this appears to be a disjointed occurrence of this bird and these adjacent protected areas may perhaps even hold a relict population of this spurfowl, since there are no reports of it in southern Rajasthan or eastern Rajasthan, or even in the adjacent areas of Madhya Pradesh. The nearest population of this bird that I know of is in the Satpura National Park of Madhya Pradesh, below the Pachmarhi massif. It would be interesting to know whether any other sightings of the painted spurfowl have occurred in Rajasthan outside this 'belt' starting from Ramgarh Sanctuary in Bundi to the Kailadevi Sanctuary in Karauli dist., or in the forests of northwestern Madhya Pradesh.

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8. MORE ON THE LESSER FLORICAN *SYPHEOTIDES INDICA* AT ROLLAPADU WILDLIFE SANCTUARY, KURNOOL DISTRICT, ANDHRA PRADESH

The Rollapadu Wildlife Sanctuary (area: 6.14 km^2), Kurnool dist., Andhra Pradesh was set up in 1982 to protect the great Indian bustard *Ardeotis nigriceps*. The Sanctuary consists of three grazing and disturbance free grassland plots (called enclosures by the Forest Department), which are surrounded by grazing lands and crop fields of the villages that border it. However, due to demands from the local graziers, only the main enclosure (Enclosure-I: 320 ha) is well

protected. Enclosure-II (40 ha) may be protected for some periods or years, while Enclosure-III (120 ha) is totally unprotected. For more details regarding the Sanctuary, see Manakadan and Rahmani (1989, 1993).

According to Sankaran and Manakadan (1990), the lesser florican *Sypheotides indica* 'winters' in Rollapadu Wildlife Sanctuary (RWS) area, and may even breed if rains fail in their breeding grounds in Madhya Pradesh and Gujarat. They gave further details of the occurrence of the lesser florican at RWS. In this paper, we provide additional information on sightings of the lesser florican at RWS during our studies (July 1992 to December 1994) under the Grassland Ecology Project of the BNHS, funded by the U.S. Fish & Wildlife Service.

Habitat Preference

During the present studies, the floricans were very partial to Enclosure-I. They were not recorded in the grazing lands or Enclosure-III, and there was one sighting in Enclosure-II, when it was protected in 1992. Within Enclosure-I, which is dominated by the *ca.*50 cm tall *Heteropogon contortus-Eremopogon foveolatus-Chrysopogon fulvus* grass community, the birds did not keep far from tall grass stands of *Sehima nervosum* or *Cymbopogon caesius* (100-150 cm). Thus, the presence of these two grass species in patches is important for the florican at RWS, which was also observed during the earlier study.

Seasonality population, territories and breeding at RWS

In years when breeding did not occur at Rollapadu (1993 and 1994), floricans arrived in January/February in their eclipse plumage. The birds were seen off and on, and by mid-June, the cocks attained their full breeding plumage, and then disappeared suddenly. During 1992, the birds were recorded during July-December (monsoon: southwest and northeast monsoons), which is the breeding season of the florican in their breeding grounds in Gujarat and Madhya Pradesh.

The number of birds recorded during 1992-1994 varied. More males, or sightings of males, were recorded than females for all the years. This is probably due to the fact that males frequent territories and attain a striking breeding plumage during mid-May to June, and hence are relatively more conspicuous than females (inspite of the skulking habits of both the sexes). The year-wise sightings are discussed below.

1992: The first signs of the florican appeared in July with the presence of feathers in Enclosure-I. In October, two cocks were seen displaying on a few occasions at two sites. These two sites were also the display sites of cocks in 1987 (when breeding was recorded). Another cock (non territorial) was also sighted. After 30th October, there were no signs of the displaying birds. By the end of October and early November, four sightings of solitary females were recorded in different areas of Enclosure-I (3 sightings) and Enclosure-II (1 sighting). The only sighting after that was of a male in eclipse plumage in mid-November and a female in mid-December.

Nests were not located, but judging by their stay in the off-season, display activity by males, and the fact that locating nests of floricans is extremely difficult, it is possible that the birds had bred that year. Also, rainfall was reportedly deficient in their breeding grounds in Madhya Pradesh and Gujarat that year, as was the case in 1987, when breeding was recorded at RWS.

1993: Both males and females were occasionally flushed in January and February. During one of these sightings, two females were seen together. After February, there was no sighting, except for a female in May. In June, two cocks were seen frequenting two sites (one of which was also used during 1992). Single sightings of two other males were also recorded. By the end of June, both the territorial males had attained their breeding plumage. In June, another bird (sex uncertain) was also flushed once in the enclosure. We were absent from the study area in July, and the next and

only sightings were in October. On two occasions, we saw a male in eclipse plumage frequenting a display site of 1987.

1994: The first signs were the presence of feathers towards the end of February. There were three sightings (sex uncertain) in March and April. On 25th April, two cocks were sighted. On our return in May after two weeks' absence, nine florican males in partial breeding plumage were seen in different parts of Enclosure-I. Four of these sites were territories held during 1987, and/or 1992 and 1993. At this time, a hen was also sighted. These birds were present till mid-June, by which time they attained their breeding plumage, and disappeared.

Conclusion

Rollapadu appears to be a regular wintering ground of the lesser florican. The birds may also breed at RWS if rains fail in their breeding grounds in Gujarat and Madhya Pradesh, as suggested by Sankaran and Manakadan (1990). Incidentally, the numbers of demoiselle cranes *Anthropoides virgo* and barheaded geese *Anser indicus* wintering in the Rollapadu area each year was found to be influenced by the quantum of rains in Gujarat. It was observed during our two study periods that during years when rainfall was low in Gujarat, as many as 10,000 cranes and about 500 geese arrive (e.g. in 1992), but if the rains are good in Gujarat, then very low numbers arrive, or the birds may not arrive at all, as in 1994.

A few sites within the enclosure were frequented and defended by cock floricans year after year, which may serve either as their breeding or wintering territories. Attainment of full breeding plumage by males prior to their migration (presumably to their breeding grounds in Gujarat and Madhya Pradesh) was observed during this study. In 1994, a population of not less than 10 birds (9 cocks and 1 hen) was recorded, which is the maximum number counted during both the studies. Lastly, since the observations showed that the florican is partial to tall grass cover, and uses the area during winter and summer, burning of the grass (whether due to accident, vandalism or as a management tool) would be detrimental for the lesser florican.

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9. THE OCCURRENCE OF COLLARED PRATINCOLE OR SWALLOW PLOVER *GLAREOLA PRATINCOLA* (LINN.) IN KUTCH

We are concerned with two races of the collared pratincole in the Subcontinent: the partly resident and mainly migratory nominate race, and *Glareola pratincola maldivarum.* This note concerns the former, which breeds sparingly in Pakistan and straggles into India and even to Sri Lanka. According to Roberts (1991) it is a common, summer-breeding visitor in lower Sind

along the border of the Great Raan of Kutch, particularly in Badin dist. Dharmakumarsinhji (THE BIRDS OF SAURASHTRA) considered it to be rare in Saurashtra, with no breeding record there. Stuart Baker (1929) includes Kutch in its range of distribution and mentions its breeding along with *G. p. maldivarum* in Sind and Kutch. So far as I know there has been no record of this latter race in Kutch. It may also be mentioned here that in any case its pattern of distribution is unclear. There is only one breeding record of this race in Sind in the 19th century (Doig, 1879). Apart from this, there seems to be no firm recent record of its breeding in Pakistan.

There is no scope for taxonomic discussion in a note of this nature, but it might be mentioned that Charles Vaurie (1965) considers the collared pratincole a separate species, and perhaps some others do too. This has also been commented upon by Dr. T.J. Roberts.

The purpose of this note is to report the occurrence of the nominate race of the collared pratincole in Kutch. In the year 1992, there was heavy rainfall during the rainy season. Many of the low lying areas of Banni grassland were inundated with shallow water and some of the marshy areas did not dry up till the month of October. In such years the Bhuj-Pachham road beyond Loria village and *c*. 5 km short of Bhirandiara there is water interspersed with patches of dry and marshy ground which from July-August onwards becomes, to use Dr. Sálim Ali's expression, a veritable index on both sides of the road for the incoming waders, etc. and a few passerine birds also. It is a unique sight to see terns sitting side by side on the telephone and electric wires with larks and bluecheeked bee-eaters!

On October 18, 1992 while standing on the edge of the embankment of the road, watching birds along with Shantilal Varu and other members of the Pelican Nature Club of Kutch, I espied a largish swallow-like bird flying in and settling down on the short vegetation-covered marshy flat ground. After seeing it through binoculars and properly studying its plumage and so on, we made sure that it was *Glareola p. pratincola*. Soon after this, we noticed a juvenile of the same species sitting nearby. It was smaller in size, darkish brown and there was no suggestion of lighter shades or white in its plumage except the breast, which appeared to have brownish and lighter shaded (buff) mottling. Judging from its size and coloration, one is inclined not to rule out the possibility of this pratincole having bred on this side of the border, and the conditions prevailing in the Banni that year were ideal for the nidification of the species.

Considering the foregoing facts, sighting a collared pratincole in Kutch is by no means impossible, but it is certainly a first record for this century. For neither Hugh Palin nor Capt. Lester listed this species and Dr. Sálim Ali did not meet with it during his initial survey and subsequent visits to Kutch.

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10. SIGHTING OF THE THREETOED KINGFISHER *CEYX ERITHACUS ERITHACUS* (LINN.) IN PUNE CITY

On October 11, 1995, a threetoed kingfisher *Ceyx erithacus erithacus* was sighted on the banks of the Mula-Mutha river in the vicinity of one of the most crowded parts of Pune. Mr. Deepak Shinde, a local forest guard, first reported having seen a 'multicoloured bird' which I subsequently identified as the threetoed kingfisher. I was deeply overwhelmed on sighting this kingfisher, which usually inhabits moist deciduous and evergreen forests and resides close to waterbodies like streams and rivulets. "During the monsoon this bird disperses far and wide and usually dies by dashing against walls or shutters of windows." (COMPACT HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali and Ripley, 1987). When I first saw this bird, it was perched on a bamboo twig and seemed to be completely exhausted. We tried to save the bird. However, on that rain-soaked, breezy, cloudy evening — an evening difficult for local migratory birds — the kingfisher was soon found to be dead. Mr. Ramesh Salunke, a taxidermist of the Zoological Survey of India, while skinning the bird, noticed fine fissures and cracks on the skull. From these head injuries it appeared that the bird had hit against something.

Dr. Savita Paknikar, a pathologist, found nothing in the stomach that could have contributed to its death. During the monsoons, the threetoed kingfisher is occasionally seen in the dry deciduous forests of the Sinhagad valley about 20 km southwest of Pune.

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11. INFANTICIDE IN HOOPOE *UPUPA EPOPS* LINNAEUS

During a stay at Corbett Tiger Reserve in Uttar Pradesh, India, I witnessed interesting behaviour in hoopoes (*Upupa epops*). I stayed at Dhikala in a house which had a wooden floor, with numerous crevices in it. According to the residents, a pair of hoopoes would make a nest in one of these holes almost every year. On March 3, 1997, the first nesting was observed . After a few days, the female started incubating while the male brought her food. Sometimes the male would bring food (usually grubs, termites etc.) almost forty times in a day. After about two weeks, the chicks hatched and faint noises from inside the hole could be heard. The female had now come out of the nest and on March 20, 1997,1 saw a hoopoe, probably a male, constantly pecking at the entrance of the nest. I saw it trying to go inside the nest in which it finally succeeded. It appeared to be pecking at something, as a lot of drumming noises could be heard. After some time, it came out with some feathers in its beak which it promptly threw down the balcony. It went back in, to come out with a live chick in its beak. This chick was also thrown down the balcony. The robbing continued, and again it managed to come out with an egg which was also thrown down.

Such systematic killing of dependent offspring by replacing males is widespread among animals and has been reported in several primate species e.g. langurs (*Presbytis entellus,* Hrdy 1977), lions (*Panthera leo,* Bertram 1975), captive rodents e.g. collared lemming (*Dicrostonyx groenlandicus,* Mallory and Brooks 1978) and among birds in male barn swallows (*Hirundo rustica),* house wrens (*Troglodytes aedon),* house sparrows (*Passer domesticus)* and female Northern jacanas (*Jacana spinosa*) as reported by Rowher (1986).

Infanticide is most likely to benefit replacements when the individual whose offspring are killed has little option but to renest with the replacing individual. Infanticide by replacing males has also been viewed as a male reproductive strategy whereby males stop females from investing in the offspring of other males (Rowher, 1986). In the case of hoopoes, the time of nesting usually starts from March and continues till May (Ali and Ripley, 1987) hence it was still very early and it is likely that the killer hoopoe was a replacement male which was trying to speed up the return of the female to sexual receptivity.

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12. FRUGIVORY BY THE GREAT BLACK WOODPECKER *DRYOCOPUS JAVENSIS*

The diet of the great black woodpecker (or the whitebellied woodpecker) *Dryocopus javensis* consists mostly of ants, termites, and grubs and pupae of wood-boring beetles and very rarely honey bees (Ali and Ripley 1983). There is no specific mention of fruit in the diet of this large woodpecker though several woodpeckers have been reported to consume fruit (Short 1982).

During the course of my study on woodpeckers of the Western Ghats, I had, on two different occasions, seen the great black woodpecker feeding on fruit.

On April 27, 1995, I found a family of four (2 adult and 2 young) great black woodpeckers at Anakkayam near Sholayar in Kerala. They were moving close to the Forest Station and were not the least bothered by the presence of the forest staff who lived in the station. I noticed the birds on a *Macaranga peltata* tree just a few metres from the buildings feeding on the dark ripe fruit. Both the adults and the young ones were plucking the berries and feeding on them.

The second instance of frugivory was noticed on May 2, 1996 at the Someshwara Wildlife Sanctuary in Dakshin Kannada district of Karnataka. A male great black woodpecker was seen perched on a fruiting *Olea dioica* tree and feeding on the ripe purple-coloured fruit. It was observed for over 10 minutes on this tree and appeared to be feeding most of the time.

Short (1982) reports that about 27% of the diet of the related pileated woodpecker (*Dryocopus pileatus*) of North America consists of various fruits, berries and nuts. However, there is no mention of fruit in the diet of the Eurasian black (*D. martius*) or whitebellied woodpeckers. Fruit may be used by the great black woodpecker to supplement insect food which is perhaps scarce in the late dry season in the Western Ghats.

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13. ATTEMPT BY REDVENTED BULBUL *PYCNONOTUS CAFER* TO FEED ON A YOUNG HOUSE GECKO *HEMIDACTYLUS FLAVIVIRIDIS*

The food of the redvented bulbul *Pycnonotus cafer* consists of fruits and berries, flower nectar, and large insects. Among the food brought for a nestling was a young lizard 9 cm long which caused the death of a 5-6 days old chick attempting to swallow it (HANDBOOK OF BIRDS OF INDIA AND PAKISTAN, Ali and Ripley 1983, Vol. 6, pp 85-88).

However, on May 20, 1999 around 0830 hrs, a bird was seen moving from one flower bed to another in our residence at Durg, Madhya Pradesh. For quite some time, the bird behaved in this manner. Ultimately, it approached a rose bed close to the boundary wall where it perched, still looking here and there. Soon it flew down to the gap between the rose plant and a bush, and pecked at a house gecko hatchling about 40 mm long. After some attempts, it managed to catch hold of the gecko and carried it to the wall where it swung the victim's head violently from side to side and even struck it against the wall. All through, it was very agitated, and soon the crippled young gecko was placed on the ground. The bird attempted to swallow it, but the morsel appeared unmanageable, so it was left.

Similar observations were made by my brother in his garden at Raipur some time ago, but in this case, the bird kept itself stationary for quite some time before attempting to capture the juvenile gecko.

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14. FLOCKING AND ALTITUDINAL MOVEMENTS OF THE BLACK BULBUL *HYPSIPETES MADAGASCARIENSIS* IN THE SOUTHERN WESTERN GHATS, INDIA

The black bulbul (*Hypsipetes madagascariensis*) is one among several species of Indian hill birds that exhibit seasonal altitudinal movements. In the Western Ghats it breeds between 1000 m and the summits during March to June, descending to the foothills in the non-breeding season (Ali and Ripley 1983). Being mainly dependant on fruit for food, it also shares the penchant for short term local nomadic movements seen among frugivorous species, possibly tracking changes in food supply over several localities. It has been noted in the Himalayan subspecies (*H. m. psaroides*) that during the non-breeding season, the bulbuls move "in parties of six to ten, but sometimes numbering up to a hundred individuals ..." (Ali and Ripley 1983). Here I describe some observations on flocking behaviour and daily altitudinal movements of black bulbuls in the Sengaltheri area of the Kalakad-Mundanthurai Tiger Reserve in southern Tamil Nadu.

The study area in the southern extremity of the Western Ghats mountain range is *ca*. 1000 m above msl. The vegetation is of the medium elevation wet evergreen forest type described by Pascal (1988). Systematic observations on 600 m long line transects and point counts (between 900 and 1350 m altitude) were supplemented

by casual observations on trails and in the vicinity of the field station at Sengaltheri (an abandoned estate house). The field station is at an altitude of 1040 m in a large clearing, offering a good view of surrounding slopes up to *c.* 1150 m.

Between March and June 1997, the encounter rate of black bulbuls (individuals or flocks) was about 0.5/transect both in the higher (1200-1350 m) and lower (900-1150 m) reaches. After July, black bulbuls were increasingly encountered in the lower reaches and on some days in October (see below) the encounter rate was about ten times higher than earlier (5/transect).

Some unusual daily altitudinal movements of large numbers of black bulbuls were noted in October after the onset of the northeast monsoon. During the second week of October, it was overcast, misty, and raining on most days. Every afternoon after *c.* 1530 hrs (except in heavy rain), black bulbuls were observed flying solitarily or in flocks over the clearing around the field station from the lower areas (at least 900-950 m) up the higher slopes (to at least 1100-1150 m) on the Neterikal side. The birds could be counted as they flew past in the afternoon. The following morning, casual observations and transect data indicated their downward movement in the reverse directions.

An impressive number of black bulbuls were involved in these movements. On October 14, a total of 445 individuals in 53 flocks were counted in 80 minutes (1540-1700 hrs). The flock size ranged from 1 (solitary) to 28 on that day (flocks) of 30-40 birds were observed on two subsequent occasions). Solitary individuals flying past were most frequent (9 of 53) followed by flocks of 3 (6), 5 (5), 12 (5), 9 (4) and 10 (4) individuals. The distribution of flock sizes is given below.

Flock size	Frequency
1 - 5	23
6 - 10	12
11 - 15	12
16 - 20	4
21 - 30	2 (25 & 28 birds)

The average flock size observed (8.4) during these afternoon flights was higher than the average 2.7, range 1-7, $\underline{N} = 14$) observed in transects, point counts, and casual observations in the mornings and early afternoons. Flocks were also observed coalescing or breaking-up while moving from tree to tree up the slopes in the afternoon. The upward movements were apparently undeterred by the coverage of the higher slopes by mist, with possibly some light rain, on some days. Besides food, differences between lower and higher areas in climate and availability of roosting sites may have influenced these movements.

ACKNOWLEDGEMENTS

These observations were made as part of my research on rainforest bird communities in Kalakad-Mundanthurai Tiger Reserve, funded by the Ministry of Environment and Forests, Govt. of India. I thank the Tamil Nadu Forest Department for research permits.

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15. PURPLE SUNBIRD *NECTARINIA ASIATICA* (LATHAM) — A NEW PEST OF GRAPES UNDER AGROCLIMATIC CONDITIONS OF HISSAR, HARYANA

Grape (*Vitis vinifera* L.) is one of the most popular commercial fruit crops in India. The commercial cultivation of this crop in Haryana State is mainly confined to its southwestern districts i.e. Hissar, Fatehabad, Sirsa and Bhiwani. Many birds such as the Indian myna *Acridotheres tristis* (Linn.), redvented bulbul *Pycnonotus cafer* (Linn.) and house crow *Corvus splendens* Vieillot cause extensive damage to the ripening grapes (Pandey and Pandey, 1990). The purple sunbird *Nectarinia asiatica* Latham (Passeriformes : Nectarinidae) has recently been found damaging ripe grapes in the experimental vineyard of the Dept. of Horticulture, Haryana Agricultural University and other vineyards of Hissar dist. *N. asiatica* is a tiny, sexually dimorphic bird. The male in non-breeding plumage looks like the female — brown to olive brown from above, pale dull yellow below but with darker wings and a broad black stripe running down the middle of its breast. Its slender, curved bill and tubular tongue are admirably adapted to probe into the flower tube and suck nectar. The purple sunbird is generally found in light deciduous or dry thorn forest, gardens and compounds where it feeds on flower nectar besides small insects and spiders etc. (Ali, 1979).

During summer months Hissar dist. generally experiences a continuous spell of dry heat, which is coupled with dust storms. The maximum temperature fluctuates from 40-47°C, minimum from 25-30° C. Relative Humidity is as low as 25-35%. During these months, very few nectar producing plants are in flower in the area. The grapes start ripening during late May to the end of June. This period coincides with the dearth period of nectar for this bird.

A change in the feeding habit is observed during these months. Since the juice of grape contains the monosaccharides fructose and glucose and is comparable with the nectar of many flora, it appears to have attracted sunbirds towards the grape crop. During the dearth period, the purple sunbird frequents grape vineyards in search of the sweet juice and has been observed in remote areas where there is no other flora, exhibiting locally migratory behaviour.

Preliminary study shows that fruit damage by the purple sunbird ranges between 2-20%. This bird is a primary pest as it penetrates the ripening berries and sucks the grape juice. However, fruitfly (*Drosophila melanogaster*) and honey bees (*Apis* spp) attack the puncutured berries later on, which results in rotting of the fruit. The whole bunch is thus rendered unfit for human consumption, causing economic loss to the growers. The attack of sunbird has also been observed on vineyards which were protected with nylon nets from birds like the bank myna, bulbul etc. The small size of the bird helps it to move across the net. The purple sunbird has not been reported as a pest of grapes under Haryana agroclimatic conditions prior to this publication.

November 11, 1997

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16. ON THE IDENTIFICATION OF *LYCODON FLAVOMACULATUS* WALL 1907

(*With two plates*)

Lycodon flavomaculatus Wall, 1907 has been a frequently misidentified species for much of its recorded history. This note provides a brief account of this history and comments on taxonomic characters of both live as well as preserved specimens. Although gross scalation character is similar in most respects to that of its other Indian congeners, its dorsal pattern is visually distinct except possibly from *L. striatus* and *L. fasciatus*. This note is intended to aid in the identification of this species.

Lycodon flavomaculatus is rare and of limited distribution (Wall, 1907; Smith, 1943; Murthy, 1991; Murthy *et al.*, 1993). It was initially reported only from Maharashtra (Sangli, Kirkee, Poona, Nasik) and Karnataka (Dharwar). Smith (1943) recorded Deolali, Oudi and Berar (Buldana), all in Maharashtra, as additional localities. The Bombay Natural History Society Collection has a specimen from Bombay (S. 1109, Coll. F. Wall, 31.xii.1907) and another from Talegaon (S.1114, Coll. A.G. Chaphekar, 27.iv.1956). Khaire and Khaire (1985) collected four specimens from Pimpri (near Pune, Maharashtra). The last record of *L. flavomaculatus* was from the Nilgiri Biosphere Reserve in Tamil Nadu (Murthy, 1991). There appear to be no other records of the species.

This species has been misidentified for much of its recorded history (Wall, 1907; pers. obs.). At first Boulenger (Wall, 1907) considered *L. flavomaculatus* to be a variety of *L. aulicus*, while Wall (1907) thought it was a colour variety of *L. jara*. After comparing a specimen from Dharwar with several specimens of *L. jara* and *L. aulicus* in the British Museum, Wall convinced Boulenger that *L. flavomaculatus* was a distinct species. He attributed their errors in identification to Boulenger's key to the genus *Lycodon* (Wall, 1907). This key was formulated prior to *L. flavomaculatus* being recognised as a valid species. Recently herpetologists have mistaken live *L. flavomaculatus* from Maharashtra and/ or photographs of this species for *L. fasciatus*, *L. striatus* and (yet again) *L. jara* (all pers. obs.). These errors may well have been caused by identifications based largely or solely on descriptions of colour and body patterns. All these snakes are a shade of brown or black with yellow or yellowish markings that could be interpreted as "yellow-spotted". While *L. striatus* is sympatric with *L. flavomaculatus* in certain areas of its range, *L. fasciatus* is not. In India, *L. fasciatus* appears to be confined to the Eastern Himalayas (Assam and probably the other northeastern states). As this species does not occur in Maharashtra and southern India, *Lycodon* that have been found in this region should not be mistaken for *fasciatus*. *L. jara*, however, has a wider distribution. It has been reliably reported by knowledgeable herpetologists from Dehra Dun (S. Mukherjee, pers. comm.); Ganjam (now in Orissa); the eastern Himalayas as far west as 85° long., Bengal; Assam (all Smith, 1943) and Itanagar, Arunachal Pradesh (Captain, unpubl. obs.). Even though Wall (1923) noted that Beddome's locality records for specimens of *jara* in the British Museum labelled "Malabar" and "Anamallays" were to be discredited, there exists a small but distinct possibility of *jara* occurring further south of Ganjam — its southernmost recorded limit. Even if one were to disregard this possibility, Ganjam (Orissa) is further south than Berar (Buldana, Maharashtra) which is the northernmost record for *flavomaculatus*. This makes the southern limit of its range possibly sympatric with that of *flavomaculatus*.

However, *L. jara* is strikingly different in appearance from *flavomaculatus*. The brownish/

purplish-black dorsum of *jara* is "uniformly stippled with white (yellow in life), this pattern is formed by small spots or short longitudinal lines, two on each scale" (Smith, 1943, Captain unpubl. obs.). Most of the dorsal scales are distinctly "twin-spotted". In contrast, *flavomaculatus* has a black dorsum with a series of small yellow vertebral spots, opposite which bars of the same colour descend and broaden to form a reticulation on the flanks (Smith, 1943, Captain, unpubl. obs.). This gives *flavomaculatus* a distinctly barred appearance (Plate 2, Fig. 3) *Lycodon jara* can thus be easily distinguished from it. The only other species which may be "acceptably mistaken" for *L. flavomaculatus* is *L. striatus.*

While keying out a live *L. flavomaculatus* specimen, the author noticed a discrepancy between Wall's (1907) original description and that provided by Smith (1943). This may have resulted in much of the present day confusion. The etymology of this species suggests that it has yellow spots (*flavus* (L) = yellow / golden; *maculatus* (L) = spotted). Wall (1907), who actually saw live *flavomaculatus,* described the pattern as "buttercup yellow roundish vertebral spots, opposite which whitish bars descend..." and went on to note that "the living specimen after being put into spirit lost its brilliant yellow in about three days, the spots being then as white as the flank bars...". Smith's (1943) key to the species of *Lycodon* (p. 257) almost certainly referred to preserved material, "...back with a series of small white vertebral spots.... *flavomaculatus*...". In his description of *L. flavomaculatus,* Smith (1943) concurred partly with Wall (1907). Contradicting his own key on page 257 (and quoted in part earlier), Smith (1943) described the body pattern as "... a series of small roundish or triangular, yellow, vertebral spots, opposite which bars of the same colour descend and broaden to form a reticulation on the flanks." (p. 262). Thus Smith's (1943) key, if used in isolation on live *L. flavomaculatus* specimens, would almost certainly mislead the user. However, the same key would work perfectly on preserved snakes! This part of the key should read "...back with a series of small white (yellow in life) vertebral spots.... *flavomaculatus*...". Two live *flavomaculatus* from Pune (=Poona) dist. in Maharashtra were examined by me. Both had yellow vertebral spots, opposite which bars of the same colour descended to form reticulations on the sides of the body. One or two flecks (closest to the ventrals) were often white.

Both Wall (1907) and Smith (1943) have separated *Lycodon flavomaculatus* and *L. striatus* on the basis of their supralabials (*flavomaculatus* - 9; *striatus* - 8). This condition was found to be valid in all the specimens examined by me (Plate 1, Figs. 1 and 2). Wall (1907) also noted that, while in *L. flavomaculatus* only one supralabial touches the nasal, two supralabials touch the nasal in *L. striatus*. Smith (1943) did not comment on this condition. Eleven *flavomaculatus* and 32 *striatus* specimens examined to test the veracity of Wall's (1907) claim. All the *flavomaculatus* specimens had only the first supralabial touching the nasal (Plate 1, Fig. 1). Only 18 (56.25%) of the *striatus* specimens examined had both the first and second supralabials in contact with the nasal. Contrary to Wall's (1907) claim, the other 14 *striatus* 43.75% (Plate 1, Fig. 2) had a single supralabial touching the nasal. Three of the *striatus* specimens examined were collected by Frank Wall. They are housed in the Bombay Natural History Society Collection. One (S. 1093) had only the first labial in contact with the nasal; while S. 1094 and S. 1095 had both the first and second supralabials touching the nasal. Evidently, this is not a stable taxonomic character that can be used to separate the two species.

In order to aid identification, photographs of the lateral view of the head and the dorsal aspect of the body of live *L. flavomaculatus* and *L. striatus* have been included (Plate 1, Figs. 1-2; Plate 2, Figs. 3-4). The nine preserved

Captain, Ashok: *Lycodon flavomaculatus* PLATE 1

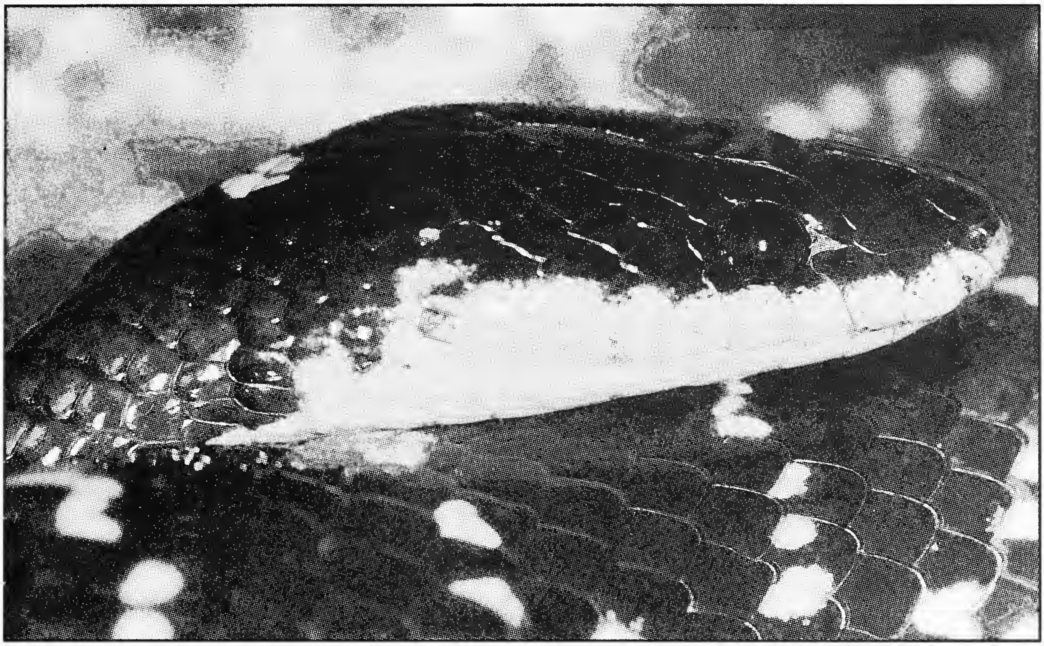

Fig. 1: Lateral view of head of *Lycodon flavomaculatus* Wall 1907, showing supralabials.

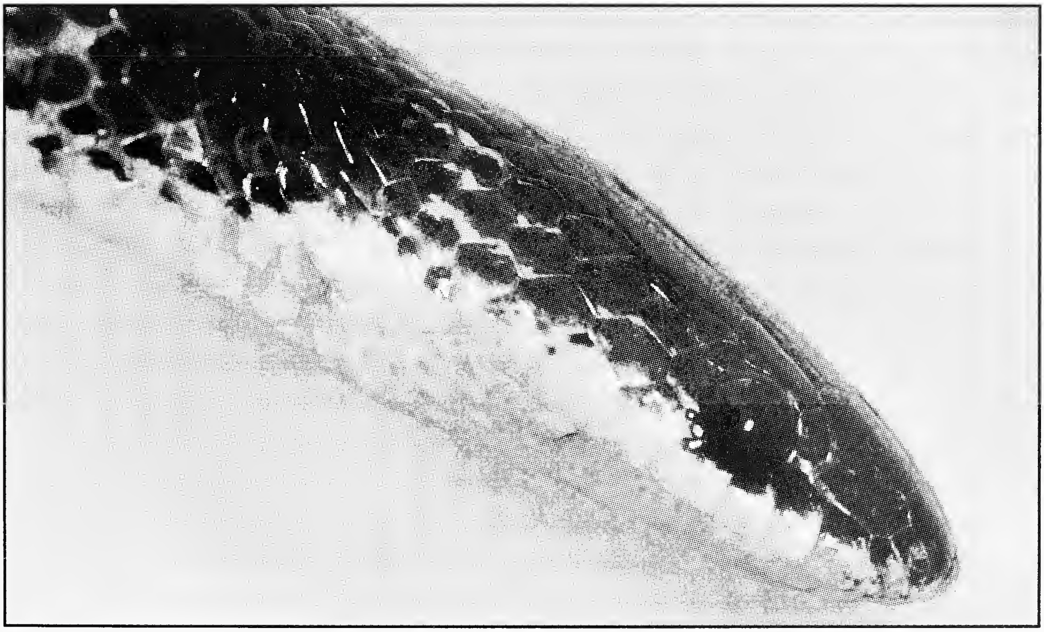

Fig. 2: Lateral view of head of *Lycodon striatus* (Shaw 1802), showing supralabials

Captain, Ashok: *Lycodon flavomaculatus* PLATE 2

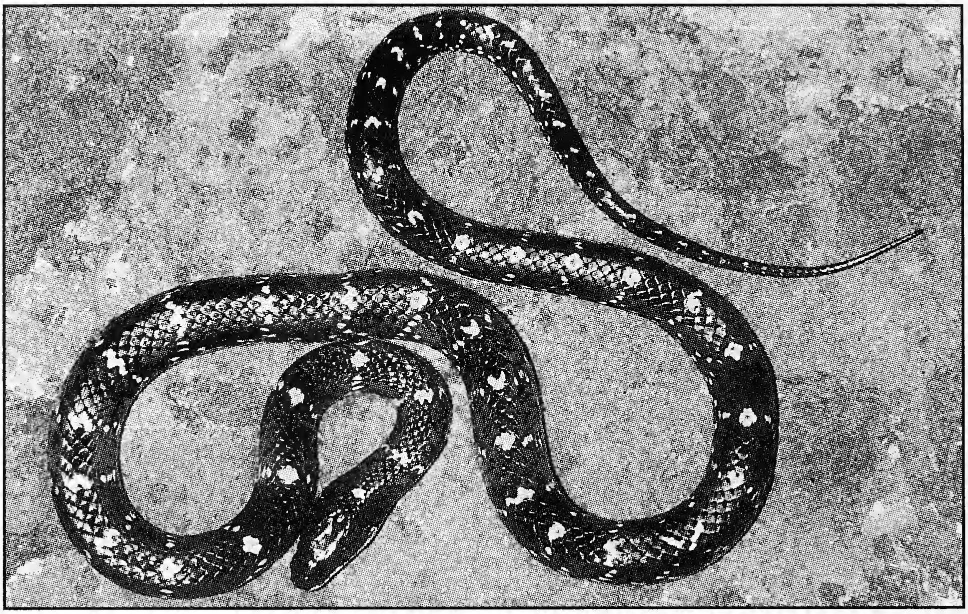

Fig. 3: Dorsal view of *Lycodon flavomaculatus* Wall 1907.

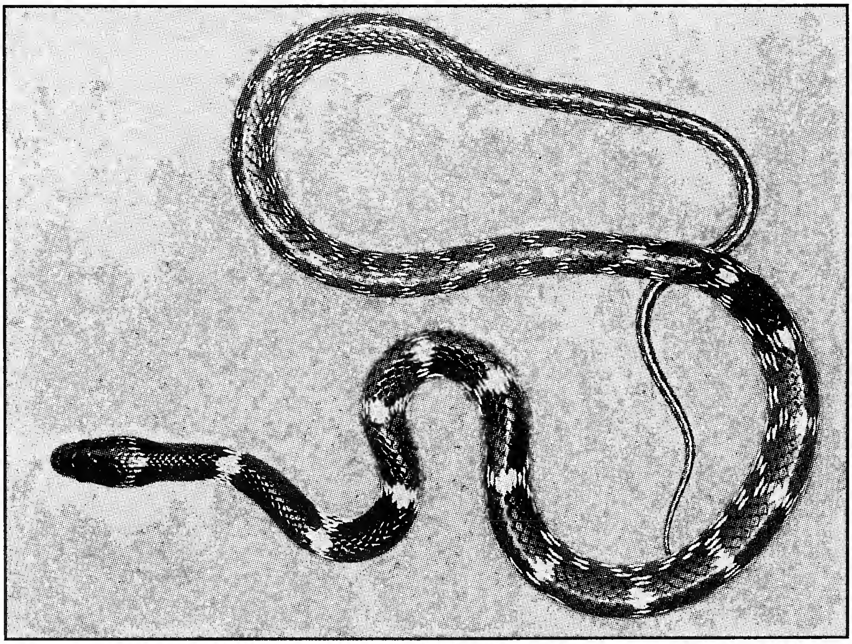

Fig. 4: Dorsal view of *Lycodon striatus* (Shaw 1802).

flavomaculatus specimens that were examined have a dorsal body pattern similar to that of the live snake in the photograph. Scalation of the photographed *flavomaculatus* is given in Table 1 as some counts were marginally outside the ranges recorded by Smith (1943).

TABLE 1
DATA ON MEASUREMENTS (IN MM) AND SCALATION OF *LYCODON FLAVOMACULATUS* WALL 1907, FROM TALEGAON, MAHARASHTRA, INDIA RECORDED ON JUNE 15, 1998

Scales (smooth):	17:17:15
Ventrals (not angulate laterally):	165
Subcaudals:	61
Supralabials (scales touching eye in brackets):	9(3-5)
Infralabials:	10
Loreal:	1
Preocular (touches prefrontal):	1
Postoculars:	2
Temporals:	2+3
Snout - vent length:	345
Tail:	95

In conclusion, distribution, if known, and dorsal pattern can be used to rule out two species of *Lycodon* that have been mistaken for *L. flavomaculatus*. Live *flavomaculatus* and *striatus* can be distinguished externally, by coloration and the difference in the number of their supralabials (*flavomaculatus* - 9; *striatus* - 8). However, having seen several kinds of supralabial aberrations in *Amphiesma stolatum, Argyrogena fasciolatus, Boiga* sp. and *Calliophis macclellandi* (Captain, unpubl. obs.) it would be reassuring to have conclusive proof that the two species are reproductively isolated.

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April 21, 1999

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17. *PISODONOPHIS BORO* (HAM.) FROM PERIYAR RIVER, KERALA COLLECTED AFTER MORE THAN A CENTURY

(*With two text-figures*)

The Western Ghats form the major watershed in Kerala and 44 rivers originate from them. Among these rivers, 41 flow westwards and the remaining flow east. In Kerala, Bharathapuzha and Periyar are considered the largest rivers. The west flowing rivers in Kerala are short and torrential due to heavy rainfall and steep gradient. The Western Ghats are ecologically one of the richest regions with great diversity of biological species. The complex topography, high rainfall, warm humid tropical climate, wide altitudinal variation and biogeographic isolation have produced a variety of ecological niches with unique plant and animal species. Diversity as well as endemism are equally represented in the Western Ghats. Fish genera like *Lepidopygopsis*, *Batasio*, *Travancoria* and *Horabagrus* are restricted to the hills of Kerala. The hillstreams and other water bodies located in the Western Ghats are very rich in fish fauna. Most of the fish species in the Western Ghats are restricted to a specific habitat. A few of them show a short distance migration. The rice-paddy eel, *Pisodonophis boro* commonly inhabits lagoons and estuaries (Talwar and Jhingran, 1991). Day (1865) states that it inhabits seas and estuaries of India and Malaysia. *P. boro* is distributed in seas and estuaries throughout India, Pakistan, Bangladesh, Burma to Malaysia (Jayaram 1981).

Periyar river originates from the Sivagiri hill ranges, that lie on the border of Kerala and Tamil Nadu. At 244 km it is the longest river in Kerala. The study area is 75 km away from the river mouth. The specimens were collected from a particular site where a small stream joins the Periyar river on its right bank (Fig. 1). This stream is seasonal, and is bordered by mahogany and teak plantations.

The area was visited during different

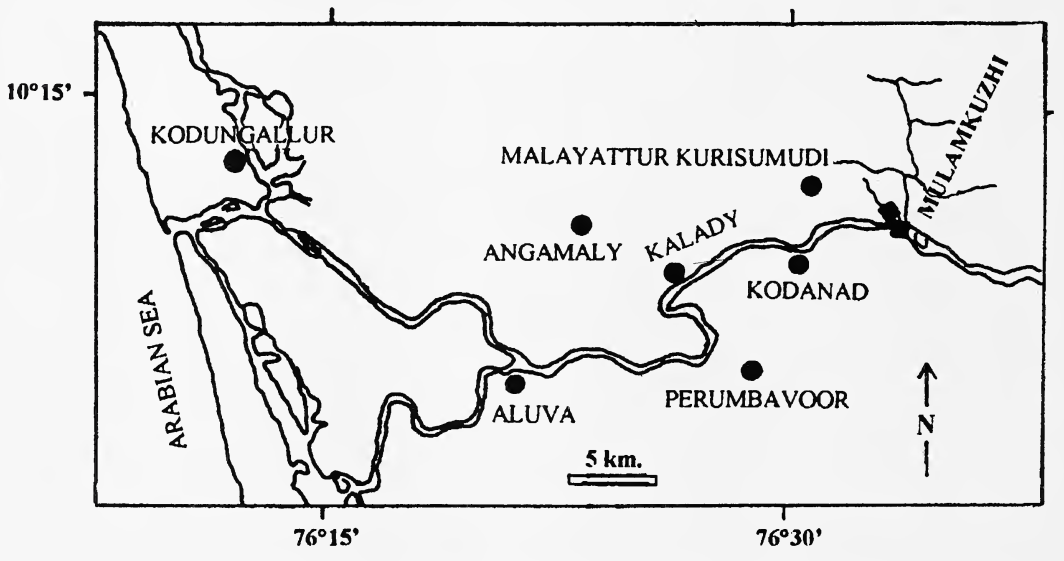

Fig. 1: Map of Periyar river showing collection sites of *Pisodonophis boro*

seasons of the year. Fish samples were collected from the river and nearby stream by cast nets, gill nets, scoop nets and temporary bunding and sieving with cloth. The rice-paddy eel, *P. boro* (Fig. 2) was collected by sieving with cloth during the monsoon season.

Water velocity was measured by an electronic flow meter and transparency by using Secchi disc. The other physical features of the habitat, viz., width, depth, substrate distribution, canopy cover and land use pattern were also assessed at the collection localities. Water DO, conductivity and temperature were measured in the field using standard methods. Works of Day (1865, 1878), Jayaram (1981), Datta Munshi and Srivastava (1988) and Talwar and Jhingran (1991) were referred for identification.

Distinguishing Characters

D. 320-335, P. 12-13, A. 240-245.

The body of *Pisodonophis boro* is eel-like or vermiform and greatly elongated. The caudal portion is not much longer than the trunk. Head acutely convex and cleft of mouth moderate. Dorsal, anal and pectoral fins present but no fin at the end of the tail. Pectoral fin well developed. Enlarged head region; the collection site of *P. boro* is shown in Fig. 1.

The first report of *P. boro* from Kerala was by Day (1865) in his book FISHES OF MALABAR. It was subsequently included in his book THE FISHES OF INDIA (1878). Since then, this species has not been reported from Kerala (Pillay 1929, John 1936, Hora and Law 1941, Hora and Nair 1941, Chacko 1948, Silas 1950, Remadevi and Indra 1986, Easa and Shaji, 1997). Though mention was made in the books by Jayaram (1981) and Talwar and Jhingran (1991), its only actual report was by Day. During our recent survey, it was collected from a small stream near the famous mahogany grove at Mulamkuzhi (Fig. 1). This indicates that the area adjacent to the mahogany grove was comparatively richer in fish fauna than the main river. A total of 9 species belonging to

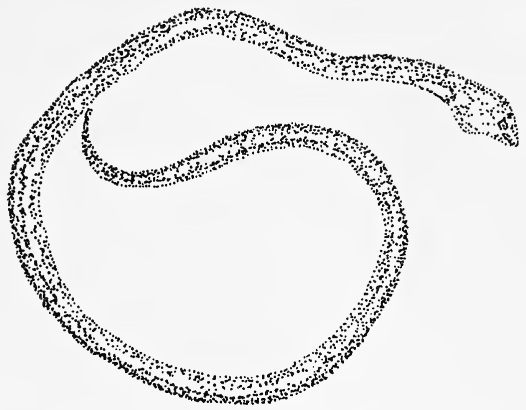

Fig. 2: *Pisodonophis boro*

4 families and 7 genera were collected from the stream, while only 4 species were collected from the main river. The following species were collected from the stream: *Puntius filamentosus, P. melanampyx, P. ticto, Danio aequipinnatus, Parluciosoma daniconius, Garra mullya* (Family Cyprinidae), *Glossogobius giuris* (Family Gobidae), *Xenentodon cancila* (Family Belonidae) and *Pisodonophis boro* (Family Ophichthidae). *Puntius filamentosus, P. melanampyx, G. mullya* and *Glossogobius giuris* were found in the main river also. All these species have a wide distribution in Kerala and other parts of Western Ghats, except *Pisodonophis boro.* The present report confirms its occurrence in Kerala, indicating its establishment in freshwaters very far from the coastal area. Three specimens (total length 340, 360 and 406 mm) were collected from the study area.

The physico-chemical parameters of the main river and stream showed a low value of total dissolved solids in the main river (10 ppm) and a high value (30 ppm) in the stream. DO was never found to be a limiting factor, with least value of 4.2 mg/1. The DO value of the main river was 6.1 mg/l. pH in the main river was greater than in the stream (7.8). This is probably due to the use of soap and detergents by the populace. The water temperature was similar at

the two locations (26.3° C in the river and 26.9° C in the stream). High flow rate was measured in the river (50 cm/sec) while it was low (15 cm/sec) in the stream. The riparian vegetation was dominated by grasses and shrubs with little canopy value. The stream is very narrow, having a width of 2-3 m, while the river is 120 m wide. Detritus, mud and sand were the dominant substrates in the stream, whereas in the main river the main substrate was bedrock (80%) with mud and sand. *P. boro* was reported from the lowland area. At the study site, the substratum was dominated by detritus and mud which may be suitable for the survival of this species.

ACKNOWLEDGEMENTS

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18. NEW RECORD OF *HETEROPNEUSTES MICROPS* (GUNTHER) (CLARIIDAE: HETEROPNEUSTIDAE) FROM WESTERN GHATS RIVERS, INDIA

(*With one text-figure*)

The stinging catfish of the genus *Heteropneustes* are found in rivers, ponds and shallow water bodies. *H. fossilis* and *H. microps* are the two known species of this genus. Among these, *H. fossilis* has a wide range of distribution and is very common along the Western Ghats.

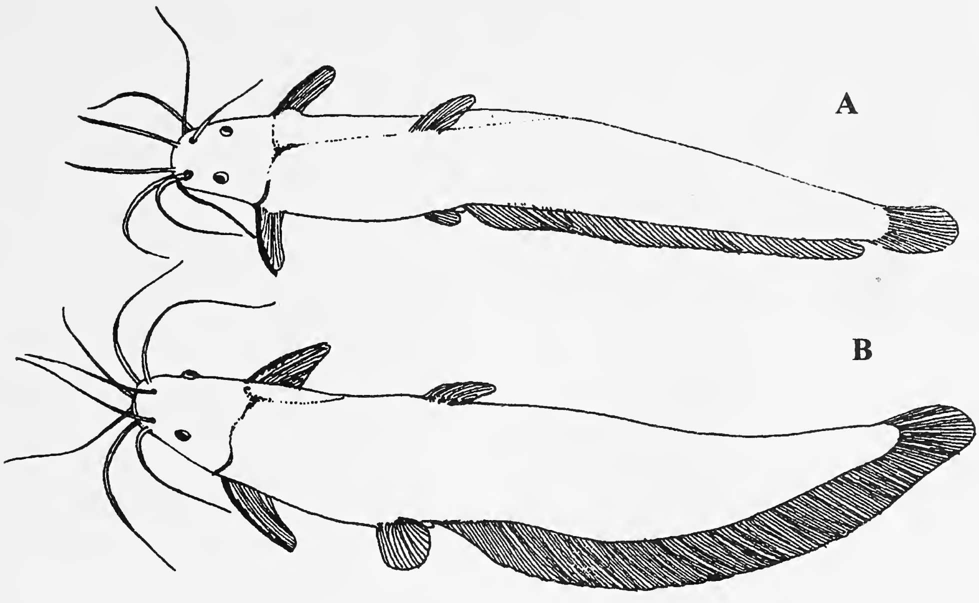

Fig.1: A. *Heteropneustes fossilis;* B. *Heteropneustes microps*

H. microps is a Sri Lankan form which has a very restricted distribution in India (Uttar Pradesh and Bihar). During a recent survey under the Western Ghats fish diversity programme, a few specimens of *H. microps* were collected from Mananthavadi puzha near Sulthan Boththery, a tributary of Kabini river (Cauvery basin), Wynaad, Kerala (Nilgiri Biosphere), and from a riverine wetland of Tamiraparani river at Thimarajapuram, Tirunelveli dist., Tamil Nadu. *H. microps* was originally described by Gunther (1864) from Sri Lanka (type locality). In India, *H. microps* has been reported only from Dambuva (near Yakvala), Uttar Pradesh and Maltidhar in Khagaria District, Bihar (Datta Munshi and Srivastava 1988). Current literature and reports on Cauvery (Day, 1967; Hora, 1942; Jeyaram *et al.*, 1982; Menon, 1992; Easa and Shaji, 1997) and Tamiraparani (Menon, 1992; Rema Devi, 1992; Arunachalam, 1996, Rema Devi *et. al.*, 1997) drainage systems show that this species was not reported from this region by earlier workers. Till now the present distribution of this species is Sri Lanka and Bihar and Uttar Pradesh, India (Talwar and Jhingran, 1991). The present record shows range extension to Western Ghats (that to southern part of Tamil Nadu and Kerala part of Nilgiri Biosphere Reserve) and distribution affinities between Sri Lanka and Western Ghats, India.

Description

DI-II/5; PI/5-6; VI/6; A+C 72-74. Body deep, elongate and compressed, its depth 5.4 times in standard length. Head more depressed, broad and 7.4 times standard length; occipital extending to basal bone of dorsal fin. Eyes small, 6.1 times in head length. Mouth terminal, lips well developed. Barbels four pairs. Dorsal fin short, inserted just behind the origin of ventral fin. Pectoral fin with strong spine, serrated along inner edge; the spine is 2/3 as long as head. Anal fin with a long base, confluent with caudal fin. There is no distinct notch between caudal and anal fin.

Geographical distribution in India: This species inhabits rivers, canals, ponds, tanks and

shallow water bodies of Uttar Pradesh and Bihar. We have recorded this species from Western Ghats for the first time.

Remarks: *Heteropneustes microps* differs from the only other known species, *H. fossilis,* in having a long-based anal fin which is confluent with the caudal fin. There is no distinct notch between anal and caudal fins (Fig. 1B), whereas in *H. fossilis* (Fig. 1A) anal and caudal fins are separated by a distinct notch.

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19. ADDITIONS TO THE FISH FAUNA OF PAMBAR RIVER, KERALA

Pambar river is one of the three east flowing rivers in Kerala. As a part of the studies on the hill-stream fishes along the eastern side of the Western Ghats, a survey was conducted in the Pambar river and its tributaries in February, 1998. Earlier, Easa and Shaji (1996) studied the freshwater fishes of the Pambar river in the Chinnar Wildlife Sanctuary area. They listed eleven species from the sanctuary part of Pambar river. In the present study, however, more species were collected from the Sanctuary area itself and other parts of the river (Tables 1 & 2).

The present survey indicated that fifteen species belonging to three families were additions to the fish fauna of Pambar river. Thus the total number of species has increased to 26.

TABLE 1
ADDITIONAL SPECIES COLLECTED FROM THE CHINNAR WILDLIFE SANCTUARY AREA OF THE RIVER

No.	Species	Endemism	Status
	Family: Cyprinidae		
	Sub-family: Cyprininae		
1.	*Puntius melanampyx* Day	EWG	Common
	Sub-family: Rasborinae		
2.	*Esomus danricus* (Ham. Buch.)		Rare
3.	*Danio malabaricus* (Jerdon)		Common
4.	*Danio aequipinnatus* (McClelland)		Common
	Sub-family: Garrinae		
5.	*Garra hughi* Silas	EWG	Very rare
6.	*Horalabiosa joshuai* Silas	EWG	Very rare
	Family: Homalopteridae		
	Sub-family: Nemacheilinae		
7.	*Nemacheilus monilis* Hora	EWG	Very rare
8.	*Nemacheilus semiarmatus* Day	EWG	Rare
9.	*Nemacheilus triangularis* Day	EWG	Common

EWG - Endemic to Western Ghats

TABLE 2
ADDITIONAL SPECIES OUTSIDE THE SANCTUARY AREA, FROM THE TRIBUTARIES OF THE RIVER

No.	Species	Endemism	Status
	Family: Cyprinidae		
	Sub-family: Cyprininae		
1.	*Cyprinus carpio communis* Linn.		Introduced
2.	*Catla catla* Val.		Introduced
3.	*Puntius aerulius* (Jerdon)	EWG	Common
4.	*Puntius filamentosus* (Val.)	EWG	Common
5.	*Puntius ticto ticto* (Ham.- Buch.)		Common
	Family: Salmonidae		
6.	*Salmo gairdnerii gairdnerii* Richardson		Rare & Introduced

EWG - Endemic to Western Ghats

The number of additional species now reach 15, of which 8 species are endemic to the Western Ghats. *Puntius melanampyx, P. filamentosus P. aerulius, P. ticto ticto, Danio aequipinnatus, D. malabaricus* and *Nemacheilus triangularis* are widely distributed in this river.

Nemacheilus monilis and *Garra hughi* are a second report from Kerala. Easa *et al.* (1997) recorded it from Bhavani river, Kerala. This loach can be easily distinguished from other species by its distinct moniliform black band along the lateral line from tip of snout to base of caudal fin. Type locality of *G. hughi* is lower Vauguvarrai estate, Travancore, Kerala. Since then there has not been any report on its occurrence in any river. According to the original description by Silas, in *G. hughi* scales were absent on the mid-dorsal streak. But in our collections, interestingly, all specimens carry scales on the mid-dorsal streak. This could be an important variation in this species.

N. semiarmatus is the first report from south of Palghat gap in Kerala. The rainbow trout, *Salmo gairdnerii* was reported only from Eraviculam stream, a tributary of Pambar river. In Kerala, this is the only area where trout have established *Catla catla* and *Cyprinus carpio communis* are the introduced species collected from the check-dam constructed at Kanthallor area. Except at the origin of Eraviculam, the temperature of all other collection localities ranged between 21° - 23.9° C. The temperature of Eraviculam stream ranged from 13° - 16.8° C.

Silas (1953) described a new genus and species, *Horalabiosa joshuai* from the Western Ghats of Tirunelveli district, Tamil Nadu, from the head-waters of the Tamiraparni river at Singampatty. For the first time in Kerala, we have collected eight specimens of *Horalabiosa joshuai* from Chinnar Wildlife Sanctuary area of Pambar river. This species is characterised by a post-labial callus structure in the mental region. It is a small hill stream fish, the body is moderately elongate and slightly compressed. Its dorsal profile is more or less convex and the ventral surface is flattened. The snout is bluntly rounded and smooth without any trace of tubercles.

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20. DISTRIBUTION OF FRESHWATER FISHES IN THE UPPALA RIVER, KASARGOD DISTRICT, KERALA

Distribution of freshwater fish fauna of Northern Kerala, north of Palghat Gap, was studied by various workers in the past (Rajan 1955, Mukerji 1931, Remadevi and Indra 1986 and Easa and Shaji 1997). However, there was no authentic record of the fish fauna of the rivers flowing though Kasargod dist, Kerala till the recent study conducted by Biju *et al.* (1999) in the Mancheswaram river, Kasargod district.

The Uppala river was surveyed by the authors in November, 1997. This river originates from the Veerakamba hills in Karnataka State at an altitude of 150 m above msl, it flows southwards about 7 km, then west about 13 km through Karnataka State. The river then flows 6 km through the Karnataka-Kerala border, enters Kasargod district, and flows in a south-west direction. After deviating in various directions the river discharges into the backwaters near Uppala, bordering the Arabian Sea. Mancheswaram river joins the same backwaters at the right bank. This river has a length of 50 km and a catchment area of 250 sq. km of which 174 sq. km belong to Karnataka State. The area under Karnataka State was also surveyed so as to have a complete picture of the distribution of fishes.

Upper parts of this river dry up within a month after the end of the southwest monsoon, so that all the fishes in this river migrate to the lower reaches. The main substratum of the river has sand and pebbles in the upper parts, while in the lower regions the bottom is muddy or sandy. Collections were made by using cast net, gill net and scoop net of varying mesh size. The list of species collected from the river is given below.

Family - Anguillidae

1. *Anguilla bengalensis bengalensis* (Gray)

Family - Cyprinidae

Subfamily - Cyprininae

2. *Puntius amphibius* (Val.)
3. *P. melanampyx* Day
4. *P. filamentosus* (Val.)
5. *P. vittatus* Day

Subfamily - Rasborinae

6. *Danio aequipinnatus* (McClelland)
7. *D. malabaricus* (Jerdon)
8. *Parluciosoma daniconius* (Ham. Buch.)

Subfamily - Garrinae

9. *Garra mullya* (Sykes)

Family - Bagridae

10. *Mystus gulio* (Ham.-Buch.)
11. *M. armatus* (Day)
12. *M. oculatus* (Val.)

Family - Belonidae

13. *Xenentodon cancila* (Ham.-Buch.)

Family - Aplocheilidae

14. *Aplocheilus lineatus* (Val.)

Family - Syngnathidae

15. *Microphis cuncalus* (Ham.-Buch.)

Family - Ambassidae

16. *Ambassis miops* Gunther
17. *Parambassis thomassi* (Day)

Family - Teraponidae

18. *Terapon jarbua* (Forskal)

Family - Gerreidae

19. *Gerres lucidus* (Cuv.)

Family - Cichlidae

20. *Etroplus maculatus* (Bloch)
21. *E. suratensis* (Bloch)
22. *Oreochromis mossambica* (Peters)

Family - Mugilidae

23. *Mugil cephalus* Linn.

Family - Gobidae

24. *Glossogobius giuris* (Ham.-Buch.)

Family - Belontidae

Subfamily - Macropodinae

25. *Macropodus cupanus* (Val.)

Most of the listed species have a wide distribution throughout Kerala. *Puntius amphibius, Parluciosoma daniconius, Danio malabaricus, Aplocheilus lineatus* and *Glossogobius giuris* were the most abundant and uniformly distributed fishes in this river. Because of the tidal influence existing at the river mouths and as far as 2-5 km away from the sea coast, marine fishes were also found in this river. *Therapon jarbua, Gerres lucidus, Ambassis miops, Mugil cephalus,* and *Microphis cuncalus* were the marine species entering the inland waters. *Mystus gulio* is also a migratory species.

The fish fauna of this river shows a distribution similar to that of Mancheswaram river, except five additions (Biju *et al.,* 1999). This may be due to its connection to the Mancheswaram river through the backwaters. Freshwater fish diversity was much less in this river, probably because of less habitat variety. The sand and mud dominated areas are the principal habitat types. Hence fishes with special adaptations are absent, except *Garra mullya.* The river mouth and areas near to river mouths had abundant fish fauna, marine and migratory species being more numerous here. The major fishery in Kasargod district is contributed by marine fishes.

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21. NEW RECORDS OF FISHES FROM GADANA RIVER, KALAKAD MUNDANTHURAI TIGER RESERVE, TAMIL NADU

Gadana river originates from Alwarkurichi and Kadyam range of Western Ghats. Three tributaries (Pampar, Kallar and Iluppaiyar) join to form the Gadana river. It has one major upstream reservoir with 60 wetlands. During flooding this river confluences with the Tamiraparani river. Gadana river basin constitutes a sub-basin of the major Tamiraparani river basin. Fish survey forms a part of detailed studies on fish habitats and communities in streams/rivers of Western Ghats, South India. We collected a few specimens (January 1997), of *Pseudambassis ranga, Glyptothorax madraspatnum* from Iluppaiyar stream, *Hypselobarbus dobsoni* from Pampar and Thoniyar streams of Gadana river. *Puntius sarana orphoides* was collected from the outlet of Gadana reservoir. These species have not been recorded in Tamiraparani and its sub-basins by earlier workers (Johnsingh and Vikram 1987, Rema Devi *et al.* 1997). Hence they are new records to Gadana river and also to Tamiraparani river basin.

Pseudambassis ranga (Ham.-Buch. 1822)

This species was originally described by Hamilton-Buchanan (1822) in the Gangetic provinces. Later it was recorded by Tilak and Tiwari (1976) from Poona dist., Maharashtra State. Ajithkumar and Vijayan (1988) recorded it from Keoladeo National Park, Bharatpur, Rajasthan.

D-vii/11-14; P-i/11-12; V-i/5; A-iii/13-15

Body stout, deep and compressed. Preopercular hind edge almost smooth with one or two serrations at angle. Head length 2.7 to 2.9 times in standard length. Eye diameter 4.5 to 5 times in head length. Lateral line 47 to 53 scales.

Glyptothorax madraspatnum (Day 1873)

This species was originally described by Day (1873) from Bhavani river at the base of the Nilgiri hills. Kulkarni and Ranade (1974) recorded it from Maharashtra State. Later, this species was recorded by Shaji *et al.,* (1995) from Aralam Wildlife Sanctuary, Kerala.

D-i/6; P-i/9-10; V-i/5; A-ii-iii/8

Body elongate. Head pointed in front. Mouth inferior, lips papillated. Adhesive thoracic apparatus well developed. Paired fins non-plaited; lateral line complete; Caudal fin deeply forked; head length 3.6 times in standard length. Eye diameter 6 times in head length.

Hypselobarbus dobsoni (Day 1876)

This species was originally described by Day (1876) from Kurnool. Menon (1992) recorded this species from Krishna river drainage.

D-ii/9-10; P-i/13; V-i/8; A-ii/5

Dorsal and ventral profiles arched. Snout obtuse. Adult male specimens have tubercles, female without tubercles. Interorbital space slightly concave. Mouth normal. Head length 3.3 to 3.7 times in standard length. Eye diameter 3 to 4 times in head length. Lateral line complete with 28-31 scales. Predorsal scales 11-12.

A.G.K. Menon described *Hypselobarbus dobsoni* and *H. jerdoni* as valid species. But Talwar and Jhingran (1991) synonymise *H. dobsoni* with *H. jerdoni.* Based on our collections from streams of the Karnataka Western Ghats and from our ongoing research projects in rivers in the Tamil Nadu part of Western Ghats, these two should be considered as valid species.

Puntius sarana orphoides (Val.)

This species was originally described by Valenciennes from Java. Menon (1956) recorded it from Manipur.

D-iv/9; P-i/12; V-i/8; A-ii/5

Body somewhat deep. Eye moderate. Mouth small and terminal. Dorsal fin inserted nearer to base of caudal fin than to tip of snout.

Head length 3.9 to 4.1 times in standard length. Eye diameter 4.3 to 4.6 times in head length. Lateral line complete with 28-29 scales. Predorsal scales 10-12.

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22. SOME OBSERVATIONS ON THE BIOLOGY OF THE PARASITIC BEETLE *METOECUS PARADOXUS* LINN. (RHIPIPHORIDAE: COLEOPTERA) ON MUD DAUBER WASP GRUBS

(*With one plate*)

The Rhipiphorid beetles *Metoecus paradoxus* Linn. are seen in grassland vegetation and are parasitoids on mud dauber wasp grubs of the family Eumenidae.

The mud dauber wasps such as *Eumenes conica* Fab., *E. edwardsii* Sauss. and *Rhychium nitidulum* Fabr. belonging to Eumenidae build small pot like cells to raise their progeny (Ayyar, 1910). The female first selects a place such as buildings, tree-twigs, or undisturbed human habitats for constructing a cell. The wasp then takes water in its mouth from a nearby water source, goes to the mud collecting place, usually a termitarium or dryland, regurgitates water on the soil surface and with the help of its mandibles and forelegs starts scraping the wet soil to make

a small globular, shiny mud pellet. The wasp then takes this pellet with its mandibles and forelegs to a previously selected place to build a small pot like cell with a small funnel like mouth. The female wasp inserts the abdomen tip into the mouth and deposits an egg inside the cell. Then the wasp goes foraging to provide paralyzed caterpillars as food for the hatching young wasp grub.

The Rhipiphorid beetles lay their eggs in the surrounding vegetation. The eggs on hatching into triungulin larvae want to catch hold of the leg of wasps coming in their way during foraging. The triungulin larva attaches itself to the wasp leg and reaches the mud cell. It passes into a period of waiting stage about 8 to 12 days inside the cell. During this period the wasp egg hatches and becomes a fleshy lemon yellow grub in about 8 to 10 days, forming a thin white membrane lining the cell wall as a whole. The minute triungulin Rhipiphorid larva at this stage loses its legs and penetrates the wasp grub, feeds as an endoparasitoid for 3 to 4 days. Then it is ectoparasitoid for about 20 days, holding the anterior part of the head of the wasp grub like a collar (Fig. A and Fig. B). Throughout the grub stage, the parasitoid beetle grub secretes a digestive enzyme which it ejects at the point of contact with the eumenid grub, keeping it from decay for about 18-20 days. Within this period the Rhipiphorid grub completes its feeding and starts pupating within the same cell (Fig. C). The pupal stages (Fig. D & E) lasts between 7 to 9 days and then slowly changes to the characteristic fully grown red and black coloured adult in a period of 38 to 42 days (Fig. F).

One interesting fact as far as the mud cell is concerned is that the parasitoid Rhipiphorid beetle, after the completion of its complicated life cycle, cannot escape out of the cell because it cannot gnaw out of the hard mud cell due to the second layer of mud coated by the female wasp brought from the termitarium. The beetle escapes if the mud cell is broken accidentally, otherwise it gets trapped and dies inside the mud cell. In case of paper wasps, sand wasps and bees, the young Rhipiphorid beetles can emerge because their nests are open in nature hence they survive. This is the first record of a Rhipiphorid parasitoid beetle from the cells of the mud nests of Eumenid wasps in India.

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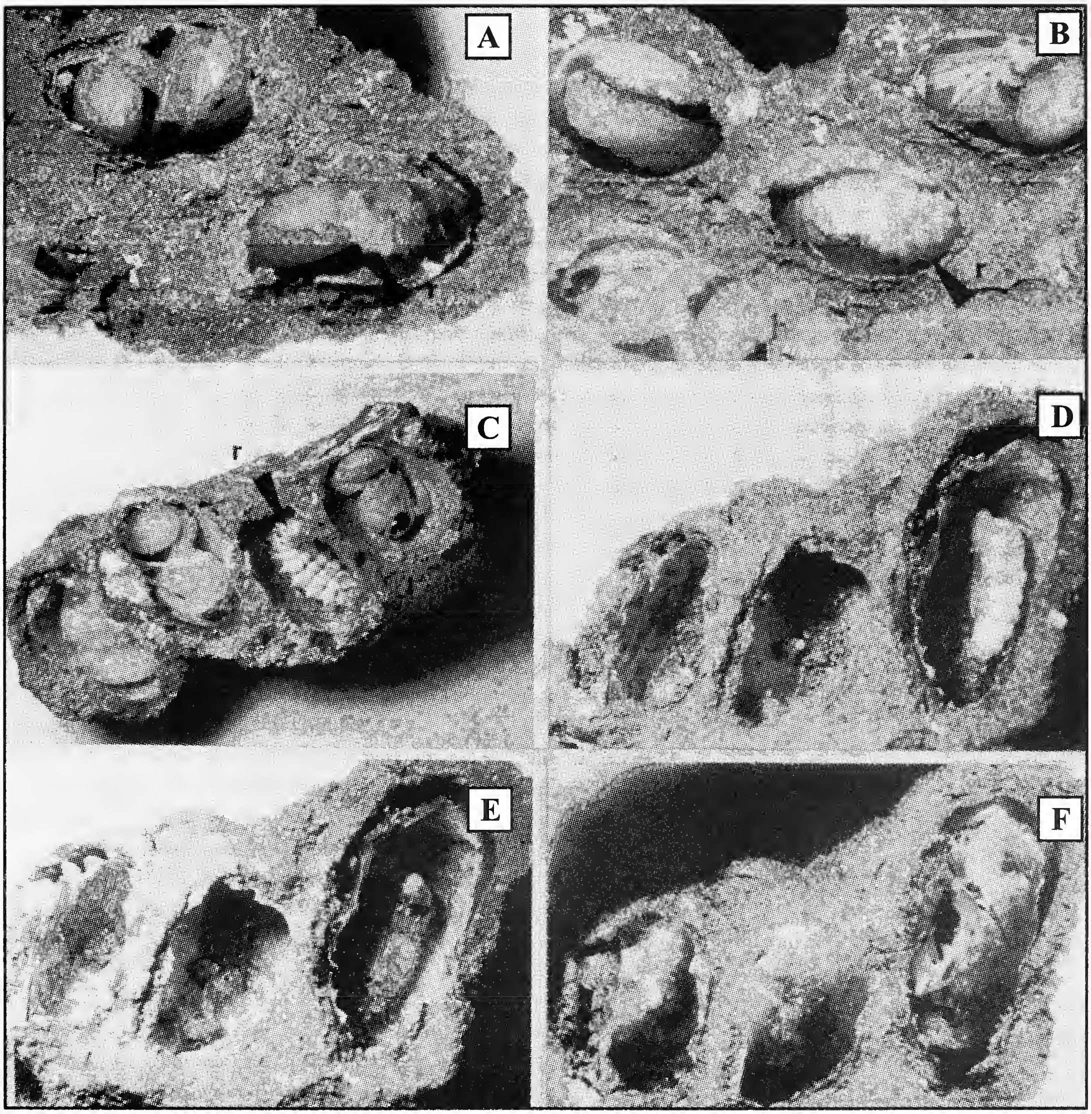
23. PREDATION BY ANTS ON FROGS AND INVERTEBRATES

On November 29, 1995, while we were walking along a perennial stream bed in Phansad Wildlife Sanctuary (Maharashtra), at around 10:30 in the morning, we noticed some army ants moving in columns along the ground. There was forest on either side of the stream. The ants were about a centimetre in length and made a buzzing sound when we blew on the densely packed columns. Though we were unable to identify these ants, from the descriptions given by Lefroy

Srinivasan, G. *et al.*: Rhipiphorid parasite beetle PLATE 1



A & B: Spiny Rhipiphorid grub feeding on Eumenid grub, r - Rhipiphorid grub, C. last instar Rhipiphorid grub within cell after completely feeding Eumenid grub, D. just pupating Rhipiphorid, E. Pupa of Rhipiphorid, F. just emerged Rhipiphorid beetle

(1984), Shivashankar and Veeresh (1987) and Hölldobler and Wilson (1990) we presume they were army ants belonging to the genus *Leptogenys* of the subfamily Ponerinae which inhabits tropical and subtropical regions.

The ants were moving in separate columns in the drier part of the stream bed, and no two columns merged though they were passing only a centimetre away. The whole column would stop, stand still and then change direction, each and every ant in the column turning at the same time. This clearly showed that communication among the ants was very well coordinated.

While the ants were moving around, one of the columns moved towards a hole at the base of a small boulder in the stream bed. The ants in the column then arranged themselves around the hole in a semicircle (10 to 15 cm radius). The entire semicircle was filled up by ants. Most of them stood still, while some near the mouth of the hole went in and attacked the frogs, which were resting inside (holes being moist).

The frogs *(Philautus* sp., *Euphlyctis cyanophlyctis* and *Limnonectes limnocharis)* jumped out and fell amidst the waiting ants. Within seconds, the ants in the semicircle overpowered the struggling frogs, which were completely covered by the ants. The ants started biting off flesh from the live frogs and ripped their bodies open. Within thirty minutes only the skeletons of the frogs were left. Some ants from this column then proceeded to another hole and carried out the same operation. Two to three columns were operating simultaneously on the stream bed. One of the columns also consumed a Mygalomorph spider (species unidentified). A crab, which emerged out of a burrow, remained quite unaffected by the attacking ants.

Yet another column climbed a Kadamb tree *(Anthocephalus indica = kadamba = chinensis)* and as the ants moved up, they broke off the termite sheeting on the trunk and preyed on the termites. The entire episode was like a well organised army operation. The common name army ants is derived from this behaviour. As soon as an ant got its prey, it turned around and started descending while the ant behind came forward and replaced it. The column went up the tree trunk to a height of around 2.5-3 m and then turned back and started descending. While they were descending, we placed a twig with 20 to 30 *Cremastogaster* ants (species unidentified) among one of the driver ant columns, expecting them to attack and devour the *Cremastogaster* ants which were much smaller (about one fourth the size of driver ants). Surprisingly. the driver ants avoided these *Cremastogaster* ants by clearing off a circular area around the twig.

We watched the entire activity of the driver ants for around two hours, after which they left the stream bed and started moving into the forest. As soon as they went in we could see grasshoppers, frogs, crickets and other invertebrates jump and try to move out of their way. Certain species of birds from South America are known to follow columns of army ants and feed on the insects flushed out by them (Willis and Oniki 1978). Though we saw many insects being flushed out by the ants we did not see any bird following the ant columns.

We have visited Phansad Sanctuary on many occasions but never seen such an event again. The proficiency with which the ants went about their work was truly impressive.

January 11, 1999

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24. MASS FEEDING OF BARONET BUTTERFLY *SYMPHAEDRA NAIS* FOSTER ON HONEY DEW DROPS

In the month of November we observed several individuals of *Symphaedra nais* feeding on the secretion fallen on the ground from the silk cotton tree (*Bombax ceiba*). The secretion appeared like oil drops sprinkled on the ground and the butterflies were rubbing their proboscis on it. On subsequent visits, the same phenomenon was observed under a *Bridelia retusa* tree overhanging the roof of a building. The secretion had fallen from the branches growing over the roof.

On taking a closer look, we observed that the leaves of *Bridelia* were heavily infested with various stages of nymphs and adult insects. The insects were collected and subsequently identified as *Tenaphalara acutipennis* Kuwayama, Family Psyllidae. They are known to feed on young shoots and leaves of *Bombax ceiba*. The nymphs exude a copious amount of honey dew and also produce a waxy secretion. Usually, 4 to 5 butterflies were seen feeding, with a maximum number upto 10 at a time. The number of individuals visiting the site was greater in the morning, and the activity continued till late noon.

We are thankful to Dr. C.A. Viraktamath Department of Entomology, University of Agricultural Sciences, GKVK, Bangalore for identifying the psyllid.

September 22, 1998 NARESH CHATURVEDI
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25. POLYMORPHISM IN THE IMMATURE STAGES OF *OTHREIS FULLONIA* CLERCK

(*With two plates*)

Seasonal colour variation in adult Lepidoptera is a known fact. It has also been recorded that early instars of a few hawk moths show seasonal colour variation (Sevastopulo, 1940).

During a survey of the lepidopteran fauna of Sanjay Gandhi National Park (SGNP), Mumbai, I made some remarkable observations on the genus *Othreis*. The genus is well represented in SGNP. *Othreis fullonia*, commonly called the Orange Underwing, is also well represented in this area. The adult of the species has been described by Hampson (1894), Barlow (1981) and its early stages by Sevastopulo (1940). However, there is no mention of its life cycle and colour variation in different seasons. Hence, a study of the life cycle of *Othreis fullonia* was undertaken. The data was collected over a period of two years from July 1995 to December 1997.

The early instars are common during the peak monsoon period and feed exclusively on *Cocculus hirsutus*, commonly called as Vasan Vel. The early instars were collected from the study site and reared at home in rearing tanks. Detailed observations were made, which are described later. A total of 173 larvae were reared during the study period.

Apte, Deepak: *Othreis fullonia* (Male)

PLATE 1

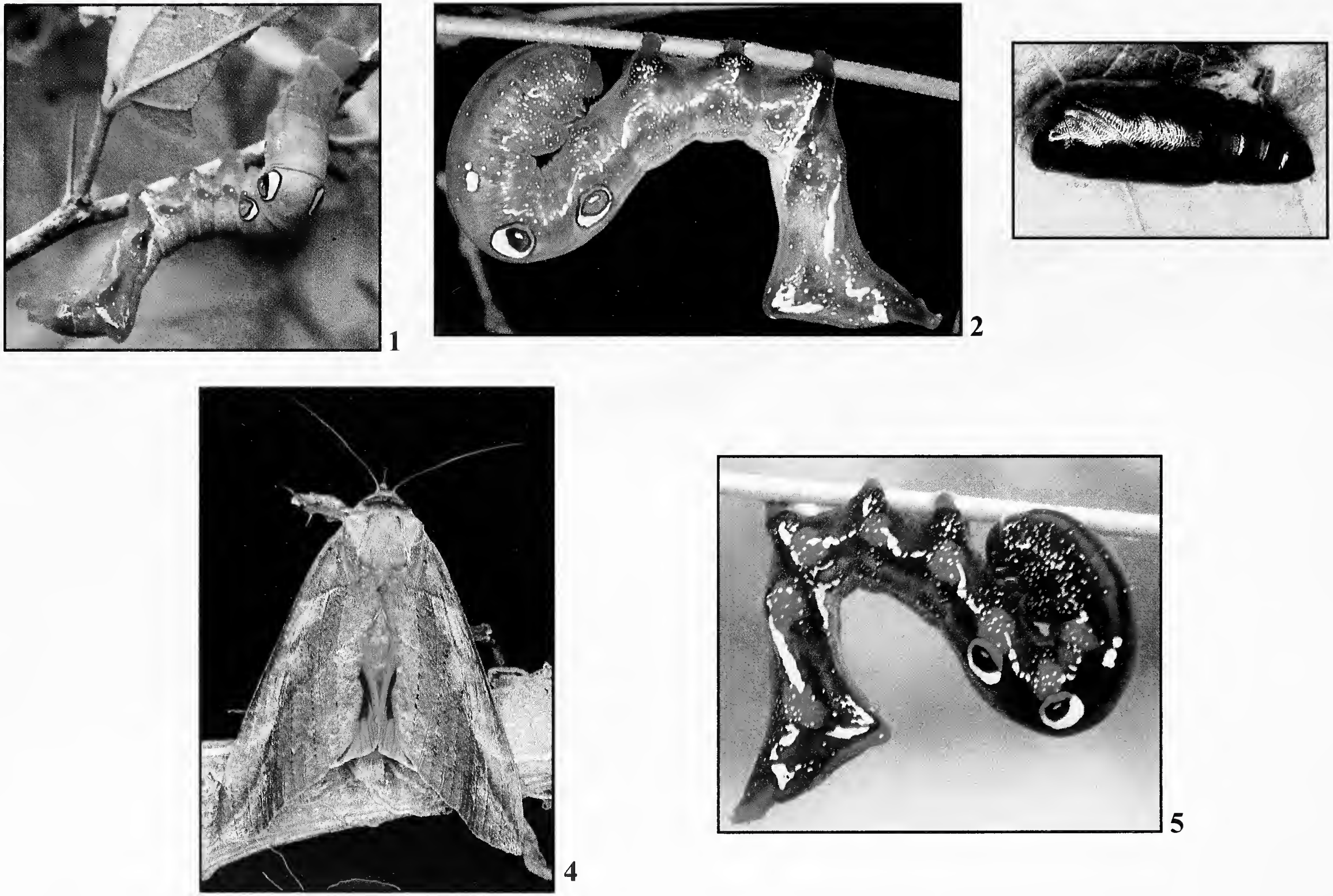


Fig. 1-4: *Othreis fullonia* wet form: 1. larva; 2. larva; 3. pupa; 4. adult male
Fig. 5: *Othreis fullonia* dry form larva

The BNHS and the author gratefully acknowledge sponsorship of the colour printing of this plate by the Mehta Scientific Education and Research Trust

Apte, Deepak: *Othreis fullonia* (Female)

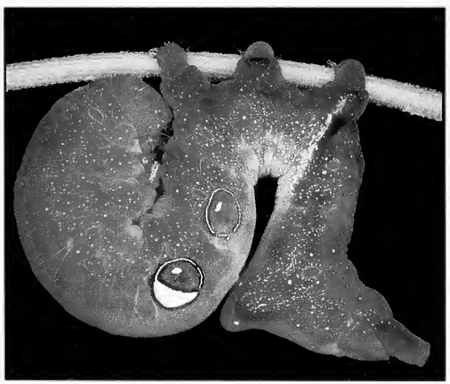
PLATE 2

1

2

3

Fig. 1-3: *Othreis fullonia* dry form 1. larva; 2. pupa; 3. adult female



4

5

6

Fig 4-6: *Othreis fullonia* wet form 4. larva; 5. pupa; 6. adult female

The BNHS and the author gratefully acknowledge sponsorship of the colour printing of this plate by the Mehta Scientific Education and Research Trust

The larval stage of *Othreis fullonia* showed sexual polymorphism. The colour pattern of the male and female larvae varies significantly in the dry and wet season. Thus, the male and female of *Othreis fullonia* can be distinguished at the larval stage. The adults showed very little colour variation.

Description of larvae

The general description of the larvae is given by Barlow (1981) and Sevastopulo (1940). The present study shows a few variations compared to earlier studies.

MALE LARVA

Wet (monsoon) form: The first three instars are green in colour. The larvae then become red brown and remain thus till pupation (Plate 1, Fig. 1-2). The legs in early instars are pale yellow and become red from 4th instar onwards. 4th and 5th instars are profusely spotted with white and blue spots which are fewer in first three instars. Spiracular patches are red and prominent and connected by discontinuous white bands. 5th and 6th somites bear black ocelli with yellow iris and white pupils.

Dry (post monsoon): The larvae are dark chocolate brown in all five instars (Plate 1, Fig. 5). The colour is much darker in the first three instars and becomes reddish brown later. Legs are red throughout. 5th and 6th somite bear black ocelli with yellow iris and white pupils. Body is profusely spotted with white and blue spots.

FEMALE LARVA

Wet (monsoon) form: Colour is dark chocolate/red brown from 1st to 5th instar (Plate 2, Fig. 4). Spiracular patches are greatly reduced and red in colour and are not connected by white band as in males. Body profusely spotted with white spots. 5th and 6th somite bear brown ocelli with white iris and white pupils. Legs red-brown throughout.

Dry (post monsoon) form: Colour blackish brown or chocolate brown (Plate 2, Fig. 1). Spiracular patches are greatly reduced and red in colour. 5th somite bears brown ocelli with yellow iris and white pupils which are greatly reduced on 6th somite. Body profusely spotted with white, and encircled by brown ring. Legs chocolate brown.

Description of pupa

After 18 to 20 days, the larva stops feeding thereafter and encloses itself among leaves. The pupa forms within 36 hours and is attached to the corner of leaves with the help of silk thread. The average pupal duration is 13 days in wet season and 18 days in dry season. Male: Dark mahogany, glossy, smaller than female (Plate 1, Fig. 3). Female: Light brown, glossy, larger than male (Plate 2, Fig. 2 & 5).

Description of Adults

The detailed description of adult was given by Sevastopolo (1941) and Hampson (1894). Palpi in both male and female are club shaped with fluorescent blue projection. Both males and females are slightly lighter coloured in wet season than in the dry season.

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26. *MACULOTRITON SERRIALIS* (DESHAYES IN LABORDE & LINNET 1834) FROM OKHA, GULF OF KUTCH: A NEW RECORD

During a survey for molluscan fauna along the Gulf of Kutch in 1995, I collected a couple of tiny shells from Okha which were identified as *Maculotriton serrialis.* The species has not been previously recorded from Okha, therefore this constitutes a new record.

Description: Specimens collected range between 8 to 12 mm. Shell with tall spires (about 7) with protoconch. Body whorl bears spiral and trans-spiral ribs which form nodules at intersections. Outer lip bears six denticles. Columella is smooth. Colour of the shell is white with two brown spiral markings on each whorl.

The species was previously recorded from Pamban (Satyamurthi, 1952), Andaman Is. and Lakshadweep Is. (Rao and Rao, 1991).

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27. ON THE OCCURRENCE OF THE PESTIFEROUS SLUGS *LAEVICAULIS ALTE* IN JORTHAN, SIKKIM

The slug *Laevicaulis alte* is an agrihorticultural pest in tropical countries (Godan 1983, Raut and Mandal 1984, Raut and Panigrahi 1990). In India, it is confined to the gardens located in the plains (Subba Rao *et al.* 1989, Thome 1989). But in recent years, a large number of *L. alte* were seen in Jorthan, Sikkim. Jorthan is a small valley close to Darjeeling.

These slugs are seen to be larger in size, darker in dorsal body coloration and healthier than those occurring in the plains of West Bengal and other parts of India. They are active only in monsoon months, when they come out of their hiding places with the approach of darkness and crawl towards the preferred food plants. They damage different kinds of potted ornamental plants as well as vegetable plants in kitchen gardens. It becomes difficult to protect seedlings and young plants of marigold, bean, gourd and cabbage. In kitchen gardens lettuce, cabbage, beans and gourd plants are damaged seriously. Adequate measures to stop further spread of *L. alte* to other valleys are imperative.

I am thankful to Mr. S.C. Mitra of Mollusca Division, Zoological Survey of India, for identifying slug specimens and to the staff of Zoology Department, Darjeeling Govt. College, Darjeeling for facilities.

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28. OBSERVATIONS ON THE FEEDING HABITS OF SOLIFUGAE (ARACHNIDA: SOLIFUGAE) IN SEMARSOT SANCTUARY (M.P.), INDIA

On May 22, 1997, I came across about 20 solifuges. As they were constantly in motion, a precise count was difficult. These solifuges were observed on the border of the Semarsot Sanctuary. They appeared to be hunting for arthropods under a street lamp. The size of the smaller solifuges was about 1 cm while a larger individual was over 4 cm long.

One of the small solifuges was trying to tear open the abdomen of a dead moth with the help of its prominent chelicerae. While it was feeding, all its legs were on the ground and its pedipalps were up in the air. The distal tip of its abdomen was raised upwards and the "head" region was touching the ground. The solifuge appeared to be feeding very vigorously.

The solifuges are known to be very active runners and also rapid consumers of food, which includes many insects such as termites. In captivity, they accept and relish crickets. Prey is caught with a swift snap of their enormous chelicerae and the vigorous mastication of food is very characteristic of the solifuges. The two scissor-like chelicerae are enormous and project in front of the prosoma. These chelicerae are extremely heavy and are as long as the prosoma in many solifuges. It is probably true to say that Solifugae have the most powerful pair of jaws in the animal world (Savory, 1977).

As I had no intention of collecting and preserving them, I quickly noted down some important features that are useful in at least deciding the genus. As the tarsus of the palp appeared narrow at its base and articulated freely with the tibia, these solifuges could be placed in the family Galeodidae. In India, this family is represented by a single genus *Galeodes* (Pocock, 1900).

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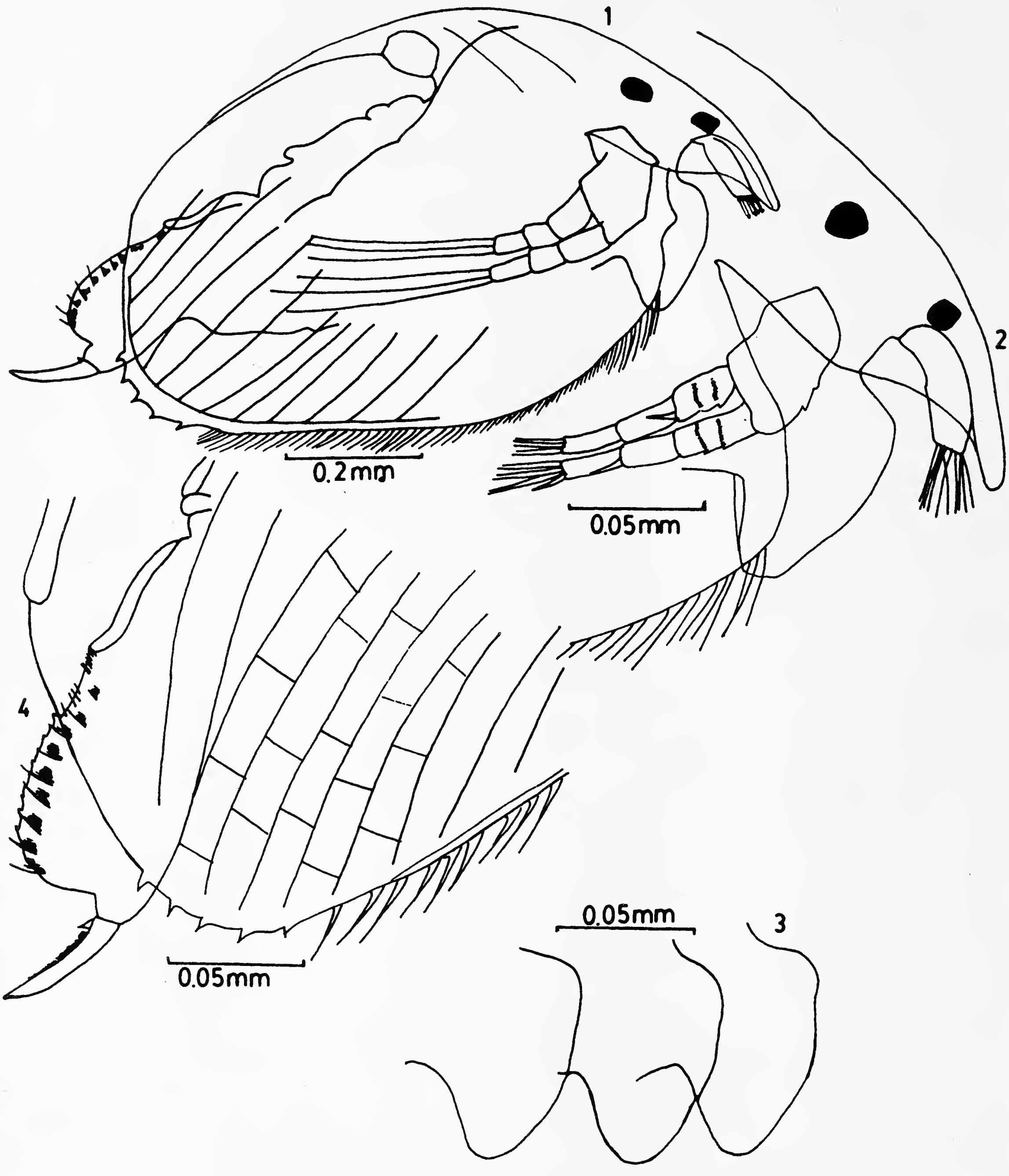
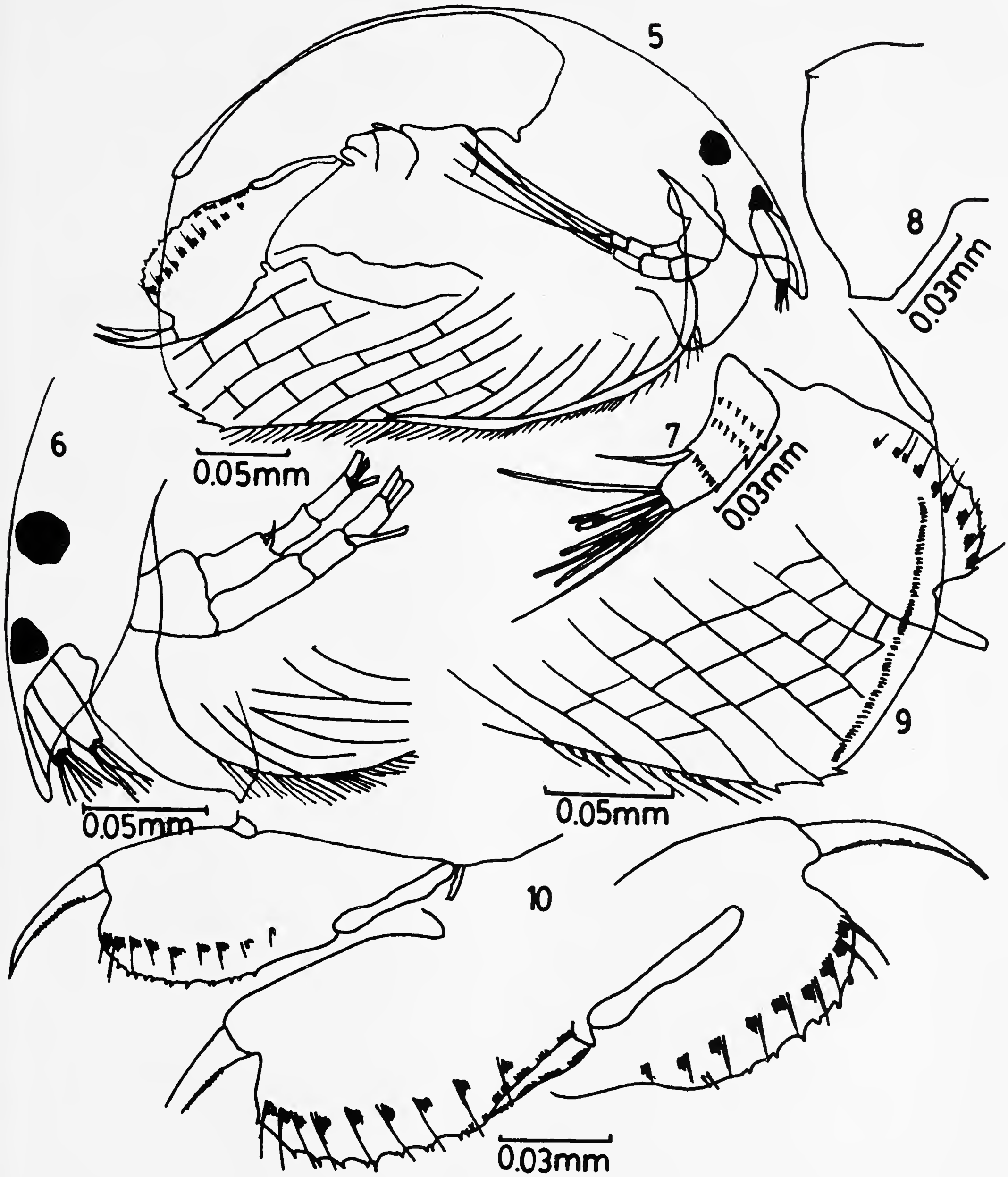
29. RESURRECTION OF *BIAPERTURA KWANGSIENSIS* (CHIANG 1963) FROM *BIAPERTURA KARUA* (KING 1853) (CRUSTACEA: CLADOCERA)

(*With ten text-figures and one plate*)

The genus *Biapertura* is a relatively small one known so far by five species, of which *B. affinis* (Leydig 1860), *B. karua* (King 1853) and *B. verrucosa* (Sars 1901) have been reported from India. Among these *B. karua* is commonly distributed between 40° N lat. and 40° S lat.



Figs. 1-4: *Biapertura kwangsiensis* (Chiang) female: 1 - lateral view; 2 - head, enlarged; 3 - labrum and 4 - posteroventral corner and postabdomen



Figs. 5-10: *Biapertura karua* (King) female: 5 - lateral view; 6 - head, enlarged; 7 - antennule; 8 - labrum; 9 - posteroventral corner and postabdomen and 10 - postabdomen.

(Smirnov, 1974). In India they have been reported from Tamil Nadu (Venkataraman, 1983), Rajasthan (Venkataraman, 1992a), Andaman and Nicobar Islands (Venkataraman, 1992b) and northeastern India (Patil, 1976; Sharma, 1978). Recently, specimens of another closely related species, *B. kwangsiensis* (Chiang 1963), described from China were collected during survey of the wetlands of West Bengal and Tripura State. In 1974, Smirnov synonymised *B. kwangsiensis* with *B. karua*, which was followed by Michael and Sharma (1988). Detailed studies using a scanning electron microscope (SEM) and a close examination of the two species reveal that they are different. *B. kwangsiensis* is reported for the first time from India and is being recorded for the first time since it was originally described in 1963.

B. karua and *B. kwangsiensis* were collected from freshwater ponds, lakes and man-made reservoirs having aquatic macrophytes such as *Hydrilla* sp., *Najas* sp. and *Chara* sp. Both species were collected using a plankton net with circular mouth of 45 cm and 70 μ mesh size. The net was dragged close to the bottom in shallow water among vegetation and the samples were preserved in 5% formalin in the field. *B. karua* was collected from Bagnon jheel, Khasipur Hugla jheel, Shibadaha jheel, Santragachi Bird Sanctuary jheel of Haura district; Dhankuni jheel, Hatgacha jheel, Baluguri jheel and Kanakund jheel of Hooghly district and Amta, Bon-Hooghly, Budge-Budge, Sarisha, Mahestala and Manikpur of 24-Parganas districts of West Bengal; also from weedy ponds of Tilliamura, Manu, Sonamura, Rajnagar, Amarpur and Udaipur of Tripura State. *B. kwangsiensis* was collected from Gholla Krishnanagar Dighi of Hooghly district and Santragachi Bird Sanctuary jheel of Howrah district, West Bengal and Gramtali, a weedy pond of Sonamura and a roadside pond of Amarpur in Tripura State.

Five gravid females of each species were separated and camera lucida diagrams were made using an ordinary monocular microscope. For SEM studies, at least ten specimens of both the species were separated and dehydrated using different grades of acetone. The air-dried samples were coated with carbon and gold, using a JEE-4x vacuum evaporator and scanned using 10 kv current under a working distance of 12 mm in a JEOL JSM-840A scanning electron microscope.

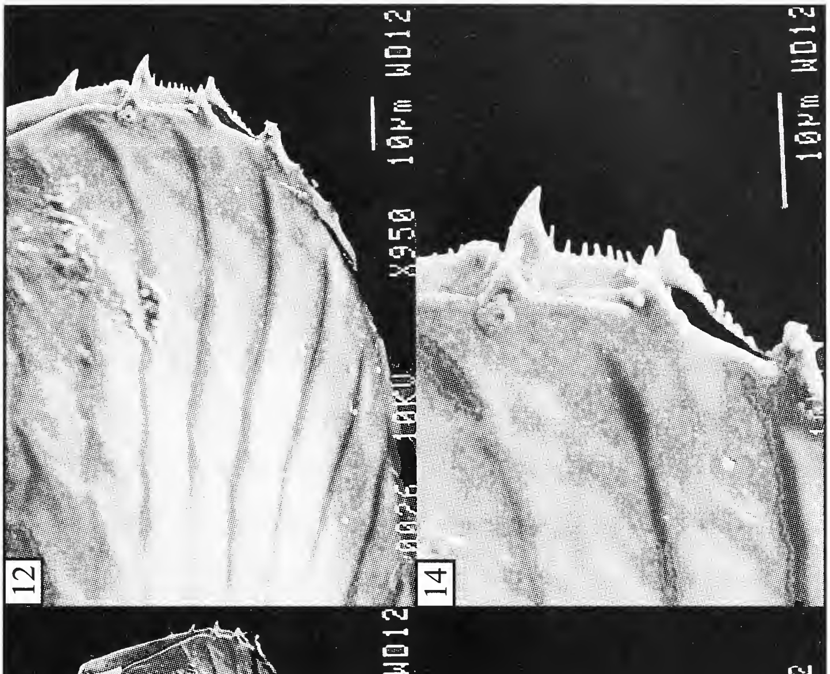
Order	Cladocera
Family	Chydoridae
Subfamily	Aloninae
Genus	*Biapertura*

Biapertura kwangsiensis (Chiang 1963)
(Figs. 1-4 and 11-14).

Female: Body size 0.45 mm (n=6), shape oval in outline, maximum height slightly before middle (Figs. 1 and 11). Valves with a series of setae, distinct lines and polygonal patterns. Ventral margin of valves with a series of setae, postero-ventral corner rounded with five denticles attached marginally upto one-third of the posterior region, followed by a row of small spines running dorsally (Figs. 2 and 12-14). Rostrum blunt, antennules not reaching the apex of rostrum. Ocellus slightly smaller than eye, situated closer to the eye than to the rostrum (Fig. 2). Labrum rounded anteriorly, blunt ventrally without a notch on the apex (Fig. 3). Postabdomen with distinct preanal and postanal corners and broadly rounded dorsal margin. About 7-8 denticles attached submarginally, followed by three groups of spines along the anal groove up to the preanal corner. Lateral side with 9 groups of setae, the distal-most setae being the longest and stoutest of each group, always projecting beyond the anal margin. Claw with very short, basal spine close to the base of the claw. Concave surface of claw with five setae in two groups, those in the proximal group longer and ending in a distinctly stouter and longer seta before the middle; distal setae ending some distance before the tip (Fig. 4). Head shield with fine striations on the surface and two connected median pores.

PLATE 1

Venkatraman, K.: *Biapertura kwangsiensis*



Figs. 11-14: Scanning electron micrographs of *Biapertura kwangsiensis* female:
11 - lateral view and 12 - 14 - posteroventral corner spines enlarged

Biapertura karua (King 1853)
(Figs. 5-10).

Female: Body size 0.32 mm (n=23), shape oval, maximum height slightly before middle (Fig. 5). Rostrum blunt, antennules not reaching the apex of rostrum (Fig. 6). Three groups of unequal sized sensory setae present at the tip of the antennule (Fig. 7). Plate of labrum cup-shaped with a notch on the apex (Fig. 8). Postero-ventral corner of valve with 2-4 denticles, separated from each other by margin of valve and situated at the postero-ventral corner extending upto 1/6 of the posterior side (Fig. 9). Valves striated, postabdomen broadly rounded with 7-8 denticles and followed by 4-5 groups of spines situated along the anal groove. Claw with a very small basal spine situated slightly away from the base. About 9 groups of lateral setae present (Fig. 10).

B. karua and *B. kwangsiensis* usually occur among aquatic macrophytes, however, they are occasionally collected in open water. Specimens of *B. karua* are relatively small, having a mean size ranging from 0.28-0.37 mm (Venkataraman, 1992a; Michael and Sharma, 1988), while *B. kwangsiensis* varies from 0.44-0.53 mm (Sieh-chich and Nan-shan, 1979).

From SEM studies, the two species can be differentiated in the following details: In *B. kwangsiensis*, there are 5 postero-ventral corner spines which possess secondary spines (Figs. 12-14), while in *B. karua* there are only 2-4 postero-ventral corner spines which are without secondary spines. In addition, the two species differ in the shape of the labrum (Figs. 3 and 8), position of postero-ventral corner spines (Figs. 4-9, 11-14) and position of basal spine on the claw. On the basis of the above differences, the two species are distinct and the name *kwangsiensis* is valid. This is the first record of the occurrence of *B. kwangsiensis* from outside its type locality and it is also the first record of the species from India.

ACKNOWLEDGEMENTS

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30. RANGE EXTENSION FOR *CEROPEGIA OCULATA* HOOK., AN ENDANGERED SPECIES OF MAHARASHTRA

While surveying Mahabaleshwar, Satara dist., Maharashtra, during October 1997, *Ceropegia oculata* Hook. (Family Asclepiadaceae) was collected on the way to Tapola lake. The plant bore flowers as well as fruit. The follicles were tender. The plant, which is a climber, had reached a height of 2 m and was scandent on a *Carissa carandas* Linn. shrub. In 1996, this species was also sighted at Panhala, near Kolhapur by me along with Dr. S.R. Yadav of Shivaji University, Kolhapur.

Bole and Almeida (1984) did not record this species while including 3 species of *Ceropegia* from Mahabaleshwar namely *C. hirsuta* Wight & Arn., *C. lawii* Hook., and *C. vincaefolia* Hook.f. This species was earlier recorded by Blatter (*JBNHS 36(3)*: 524-37, 1932) from Konkan, Ansari (1984) from Maharashtra, without any precise locality. Hooker (FBI IV, 1885) from Bombay, Chaturvedi *et al.* (1990) from Pune, Ratnagiri and Raigad dist., Mistry (1989) from Mirya, Ratnagiri dist. (*JBNHS 86(3)*: 478) and Santapau (Botanical Memoirs no. 4, 1960) from Khandala, Sinhagad fort and Purandhar.

January 29, 1998

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31. *AEGINETIA PEDUNCULATA* (ROXB.) WALL. (OROBANCHACEAE) A NEW RECORD FROM BIHAR

(*With one text-figure*)

During a field trip to Katihar dist., Bihar, in August 1997, we collected an interesting plant of the Family Orobanchaceae with attractive, colourful flowers (Fig. 1) growing in wet grassy fields along canal sides, 2 km north of Durgasthan, Rajendra Nagar (Katihar town). After scrutiny of the literature and specimens from the Central National Herbarium (CAL) the taxon was identified as *Aeginetia pedunculata* (Roxb.) Wall., and a new record for Bihar, although it is mentioned by Haines (1921-25) as likely to occur in this State. The voucher specimen has been deposited in the Bhagalpur University Herbarium (BHAG).

Aeginetia pedunculata (Roxb.) Wallich, Pl. As. Rar. 3. 13. t. 219. 1832; Hook. f. Fl. Brit. India 4: 320. 1884; Duthie, Fl. Upp. Gang. Plain 2: 34. 1960 (Rep. ed).; Prain, Bengal Pl. 2: 778. 1903 (Rep. ed. 2. 580. 1963), Haines, Bot. Bih. & Ori. 2: 673. 1961 (Rep. ed.); Guha Bakshi, Fl. Murshidabad. 231. 1984. *Orobanche pedunculata* Roxb. Hort. Beng. 45. 1814 and Fl. Ind. 3: 29. 1832.

Fl. & Fr.: Monsoon (July - October).

Locality: About 2 km north of Durgasthan (Canal side) Rajendra Nagar, Katihar town (25.4° E & 87.6° N)

Ecology: Growing in wet grassy fields along Canal, specially on the roots of *Hemarthria compressa* (L.f.) R. Br. Flowers very colourful and attractive; rare.

Material examined: Durgasthan (Katihar town,

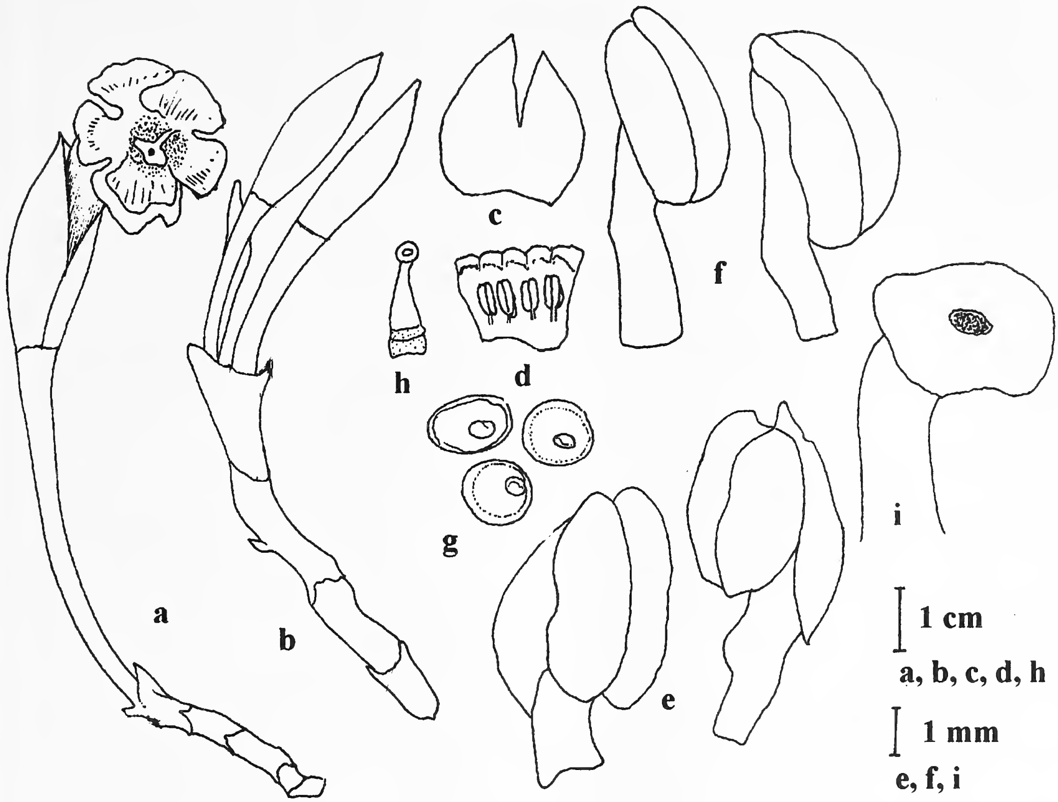

Fig. 1: *Aeginetia pedunculata* (Roxb.) Wall. a-b. Habitat, c. Calyx, d. Corolla split open with stamens, e. Stamen with anther spurred, f. stamen without spurred, pollen grains, h. Pistil, i. Stigma with part of style

Bihar) 24.viii.1997, Coll. Sanjib Kumar 529. Confirmed with C.B. Clarke no. 21793 D Jessore (25.vi.1874) Acc No. 329511 CAL.

ACKNOWLEDGEMENT

We are thankful to Dr. M. Sanjappa, Deputy Director and In-charge, Central National Herbarium, Howrah (Botanical Survey of India) for providing herbarium and library facilities.

February 14, 1998

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32. A NEW VARIETY OF *COSTUS SPECIOSUS* (RETZ.) SM.

(*With one plate*)

Costus speciosus (Retz.) Sm. var. ***dilnavazii*** (var. nov.) this variety was first observed by the senior author near Film City, Goregaon, Mumbai. It was growing side by side

with the typical variety of the species. The specimens of both the typical and the new variety were collected and studied by dissecting floral parts. Except the coloration of the corolla and the basal portion of the labellum, no other morphological differences were observed. Therefore, this new taxon is considered as a variation in *Costus speciosus (*Retz.) Sm. and a new varietal name *Costus speciosus* (Retz.) Sm. var. *dilnavazii* M.R. Almeida & S.M. Almeida var. nov. is proposed in honour of Mrs. Dilnavaz Variava, Vice President of Bombay Natural History Society in recognition of her contribution to the conservation movement in India.

The main differences in the two varieties are as follows:

Costus speciosus (Retz.) Sm.: 1. Corolla pure white in colour. 2. Labellum with yellow centre.

Costus speciosus var. *dilnavazii* Almeida & Almeida: 1. Corolla rose-pink in colour. 2. Labellum pink throughout.

Colour pictures of both the varieties which were taken on subsequent trips are given in Plate 1.

The rhizomes of this new variety have been planted in the premises of the Conservation Education Centre, Bombay Natural History Society, Goregaon, Mumbai.

Holotype: Goregaon (M.R. Almeida - G. - 501, BLAT).

Costus speciosus (Retz.) Sm. var. *dilnavazii* var. nov. similis varietas typicus differt corolibus roseus et cororolibus basi non flavus. Holotypus: M.R. Almeida - G - 501, lectus at Goregaon, mense Augusto 1997, Depositus at BLAT.

March 2, 1998

M.R. ALMEIDA,
S.M. ALMEIDA,
Blatter Herbarium
St. Xavier's College,
Mumbai 400 001.

33. *ASPARAGUS DENSIFLORUS* 'SPRENGERI' ROBUSTUS - AN ADDITION TO THE ORNAMENTAL FLORA OF ANDAMANS

The genus *Asparagus,* which includes the edible vegetable *A. officinalis,* also has a number of species and varieties grown indoors for their attractive feathery foliage, consisting of finely divided and flattened modified branchlets resembling leaves. Indoor asparagus plants are commonly called asparagus ferns because of their superficial resemblance to the foliage of pteridophyte ferns.

As far as ornamental value is concerned, *A. asparagoides* (Smilax), *A. densiflorus* (Mayeri and Sprengeri), *A. falcatum* (Sicklethorn), and *A. plumosus* syn. *A. setaceus* (Asparagus fern), are some of the exotic species or varieties which are of common use in gardens and as indoor plants in Andaman and Nicobar Islands. Reports on the flora of Andaman (Vasudeva Rao, 1986) reveal that A. *racemosus* grows wild in the Andamans.

During an exploration of horticultural flora of Andamans, *Asparagus densiflorus* 'Sprengeri' Robustus was found growing wild on rocks in forests of Mundapahar, Chidyatappu, South Andaman. The present report on the occurrence of this species in the islands is of great phytogeographical as well as floristic interest.

Specimen examined: South Andaman Mundapahar, Chidyatappu on rocks near the seashore.

The plant is of strong growing habit and has pliable drooping stems, about a metre long. The stems are lightly covered with 1-1.5 cm long, soft, needle-like branchlets which usually grow in groups of 4-5 at the node. The colour of foliage is dull green. The stem near the joint of branchlets or below that bears small (0.5 cm) thorns. The plant bears 4-5 clumps at the base.

Almeida, M.R. *et. al.*: *Costus speciosus* PLATE 1

Costus speciosus (Retz.) Sm.

Costus speciosus var. *dilnavazii* Almeida & Almeida

Since these plants are found growing very near the seashore at Mundapahar, it is also assumed that they may be an exotic introduction brought in long ago which escaped from gardens and naturalised. *Asparagus* species with horticultural scope are widely cultivated in tropics and sub-tropics for the appealing floristic shape and form. This economically and horticulturally important species could probably be a promising genetic resource.

March 18, 1998

D.B. SINGH
SUJATHA A. NAIR
T.V.R.S. SHARMA
Central Agricultural Research Institute,
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REFERENCE

Vasudeva Rao, M.K. (1986). A preliminary report on the Angiosperms of Andaman and Nicobar Islands. *Econ. Tax. Bot. 8(1)*: 107-184.

34. *POA HARAE* RAJB. (POACEAE): A NEW RECORD FOR INDIA

(*With one text-figure*)

During recent plant explorations in the alpine zone of Garhwal Himalaya, some interesting specimens of *Poa* L. were collected. After thorough checking of literature and consultation of Herbaria at Botanical Survey of India, Northern circle, Dehra Dun (BSD) and Forest Research Institute, Dehra Dun (DD), these specimens were identified as *Poa harae* Rajb.

This species was earlier described by Rajbhandari (1988), believed to be endemic to E. Nepal, however, the recent collection from the alpine zone of Garhwal Himalaya not only represented its westward distribution but also an addition of *Poa* species in India.

A description, and line diagrams of various parts of the plant specimens are given to facilitate identification. The voucher specimens are deposited at the Herbarium, Department of Botany, H.N.B. Garhwal University, Srinagar (Garhwal), India (GUH).

Poa harae Rajb. in Acta Phytotax. Geobot. 39: 55. 1988; Rajbhandari in THE HIMALAYAN PLANTS (ed. Ohba & Mala) 2: 205-206. 1991.

Perennial, tall, tufted grass, with stoloniferous base. Culms terete, erect, 20-40 x 0.1-0.15 cm, minutely scabrous below the panicle; nodes 2-3. Leaf blades flat, linear, acuminate, 8-12 x 0.1-0.15 cm, nerves and margins minutely scabrid; Sheaths 6-10 cm long, glabrous; ligules oblong, acute, 2.6-3 mm long. Panicles oblong, 4.5-9 x 0.8-1.5 cm; branches spreading; axis terete, scabrid; lower branches 2-5, scabrid; pedicels scabrid; spikelets mostly proliferating. Normal spikelets elliptic, 4-5 mm long, with 2-3 florets. Lower glumes lanceolate, acute, 3.2 mm long, 3-nerved, glabrous, with scabrid keel on the upper part; Upper glumes elliptic, acute, 4 mm long, 3-nerved, glabrous, with scabrid keel above. Rhachillas 0.8-1 mm long, smooth. Callus glabrous. Lowest lemmas elliptic-lanceolate, acute, 4.2 mm long, minutely scabrid on surface, margins hyaline, keel ciliate on lower part to the middle, scabrid above, marginal nerves ciliate on lower part. Paleas elliptic-oblong, 3.5 mm long, outer surface glabrous, with scabrid keels. Anthers 1.1-1.5 mm long.

Fl. & Fr.: Aug.-Sept.

Habitat: Along crevices, rock shelters, of moist alpine glacier zones, 4600-4800 m, Gaumukh (Uttarkashi).

Distribution: E. Nepal, India, NW Himalaya; in moist habitats of alpine meadows or along glaciers.

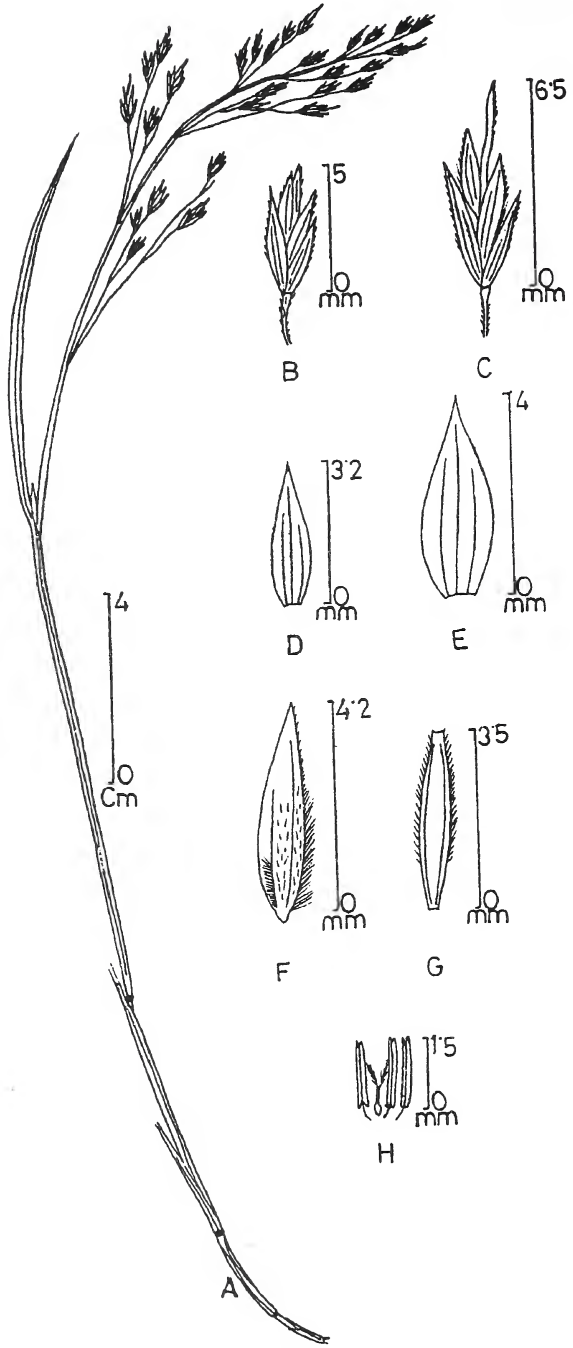

Fig. 1. A-H. *Poa harae* Rajb.
A. Plant; B. Normal spikelet; C. Proliferous spikelet; D. Lower glume; E. Upper glume; F. Lowest lemma; G. Palea; H. Anthers, Styles, Stigmas and Ovary.

Specimen examined: India, Nandanvan (Uttarkashi), 4600-4800 m, Aug, 1997, D.C. Nautiyal, GUH: 13504.

ACKNOWLEDGEMENTS

We thank the authorities of Botanical Survey of India, Northern circle, Dehra Dun (BSD) and Forest Research Institute, Dehra Dun (DD) for providing Herbarium facilities. Financial assistance from CSIR, New Delhi is gratefully acknowledged.

March 18, 1998

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■ ■ ■

ERRATA

Vol. 96, No. 1, April 1999, p 146, line 2.

For *superciliaris* read *parva*

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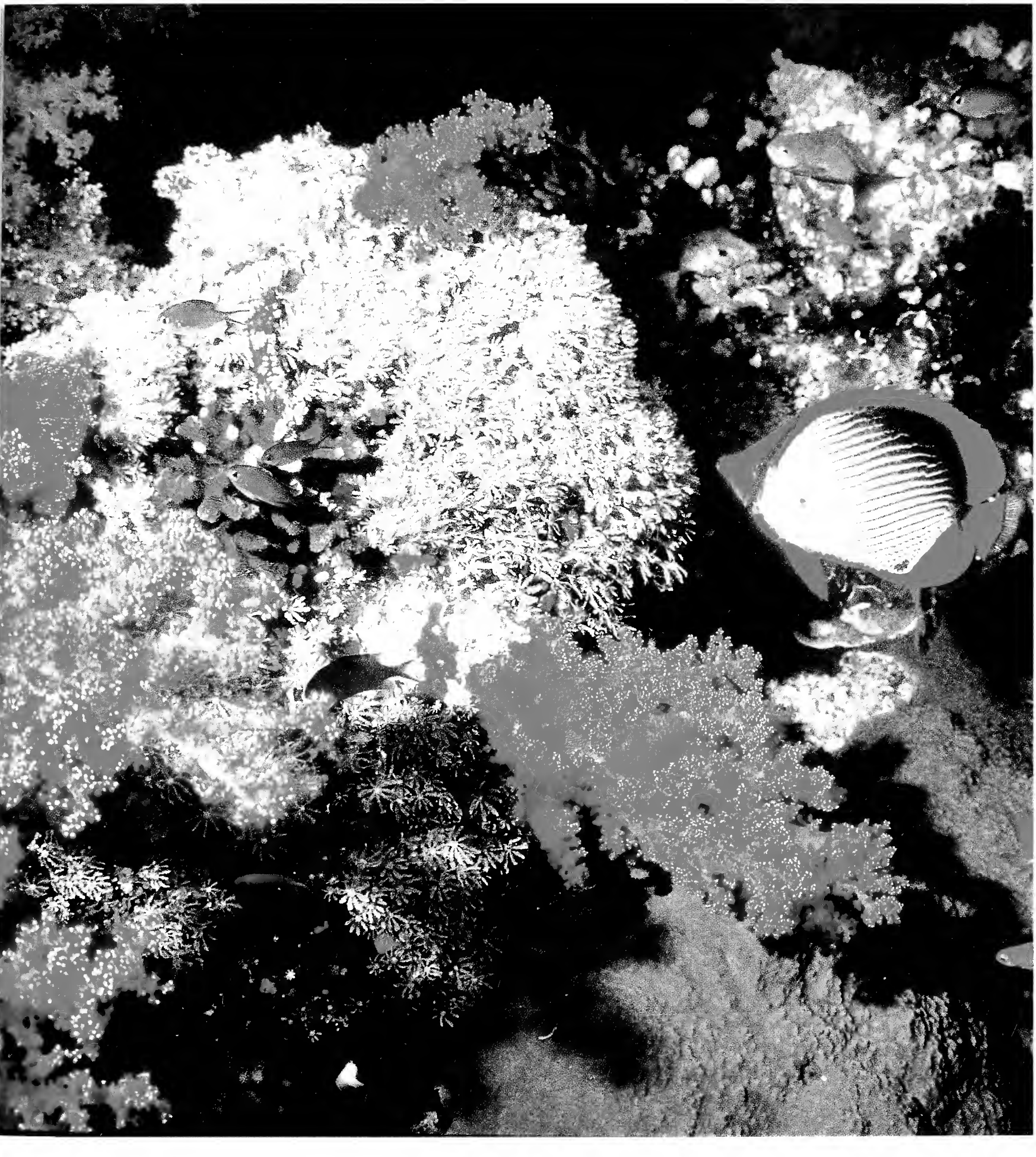

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   Prater, S.H. (1948): The Book of Indian Animals. Bombay Natural History Society, Mumbai. pp. 35-48.
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EDITORS,
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Cover Photograph: Coral Reef
Dos Winkel / Porpoise Photostock

Editorial

Dip your head into the sea, or even look over the side of a country craft anywhere in the Gulf of Mannar, and you will see an idyllic scene. Dense beds of turtle grass, with turtles leisurely ambling along. A dugong or two paddling their way and nibbling the grasses. A little distance away is a patch of bare sand littered with sea cucumbers and sacred chanks. And spread all over are reefs of coral, with their flamboyant coloration rivalling a rainbow. Among the corals, reef fishes flit in and out, equally gaudily painted.

The biological diversity off the 21 islands in the Gulf is so great that this region, extending from Rameswaram Island on the north to Tuticorin on the south, between latitudes 8° 47'-9° 15' N and longitudes 78° 12'-79° 14' E, has been notified as a Marine Biosphere Reserve — India's first.

Some two decades ago, the corals were under threat from a marine predator, the crown-of-thorns starfish. This large sea-star, with up to 23 arms armed with long, venomous spines has a gruesome feeding habit. Spreading its arms over a live coral, the sea-star squirts its digestive juices over it. After some time, it slurps back the digested coral tissues and moves on, leaving a dead mass of coral. A population explosion of the sea-star, starting in Australia, caused a slow westward migration until they reached India and attacked our corals. The crown-of-thorns starfish menace has fortunately subsided, but a new one has replaced it. This is the bleaching of live corals. The vivid colours of most corals result from hordes of microscopic symbiotic zooxanthellae. Under stress, such as unduly high water temperature, the corals eject their zooxanthelleae from their bodies and appear bleached.

These are unavoidable natural disasters, but man-made stresses are also affecting the local coral ecosystems. Especially off Tuticorin, there is thermal pollution caused by the hot coolant water discharge from the local thermal power station, as also chemical effluents from a marine chemicals manufacturing factory. A new threat looms over the horizon. It is proposed to construct a canal, called the Sethu Samudram Ship Canal, to enable large ships to cross from the Arabian Sea to the Bay of Bengal without having to go around Sri Lanka. At present, ships cannot ply here because of the shallow 3.5 m coral reef called Adam's bridge at Pamban, near Rameswaram, between the southeastern coast of India and Talaimannar at Sri Lanka. This canal will originate from Tuticorin new harbour, extend northeast upto the Mansfield patch south of Pamban Island, cut through this island and proceed parallel to the International Medial Line as the Bay of Bengal channel. It will cut the existing road between Rameswaram and Dhanushkody.

The report states that "as the proposed alignment (of the canal) is more than 5 km away from the existing 21 National Marine Parks in the Gulf of Mannar, the marine biological resources around the islands will not be affected *to any significant level.*" Nature lovers counter: Is this distance of 5 km far enough as not to cause siltation, oil pollution from ships, etc.? The official answer: "There would not be any significant change in water quality including turbidity due to the proposed deployment of ... dredgers ... (the) impact ... if any, cannot be assessed at this juncture." The magnificent coral reefs along many of the Andaman and Nicobar Islands are being choked by runoff of soil loosened by indiscriminate logging of timber. Those of the Lakshadweep are suffering from overexposure to tourism. Will it now be the turn of the coral ecosystem in the Gulf of Mannar?

B.F. CHHAPGAR

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STATUS OF VULTURES IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN, WITH SPECIAL REFERENCE TO POPULATION CRASH IN *GYPS* SPECIES[1]

VIBHU PRAKASH[2,3]

(*With six text-figures*)

Key words: white-backed vulture, long-billed vulture, king vulture, population crash, stable population, pesticide contamination, captive breeding

Seven of the eight species of vultures reported from the Indian subcontinent are recorded from Keoladeo National Park, Bharatpur, Rajasthan. The vegetation of the Park is described as Tropical Thorn Forest, which is very widespread in the country as it covers the entire semi-arid and parts of the Deccan plateau bigeographical zones. The population and distribution, including the nesting distribution, of the vultures was studied between the years 1985-88, 1990-92, and 1996-99. A sharp decline in the population of *Gyps* species was recorded over a decade. A decline of 96% was recorded in the population of white-backed v ılture and 97 % in long-billed vulture. The population of king and Egyptian vultures remained stable over the decade, as is expected in the population of large and long lived birds. Possible reasons of the decline in vulture populations are discussed. Circumstantial evidences suggest pesticidal contamination and disease as the most likely causes of population decline. Detailed investigation for the cause of population decline, like determination of pesticide load in vulture and its food, attempts to detect a possible pathogen and genetic diversity are suggested for conserving the species. Captive breeding is suggested to save the white-backed vulture from imminent extinction.

INTRODUCTION

Eight species of vultures are reported from the Indian subcontinent (Ali and Ripley 1983) of which seven species are recorded from Keoladeo National Park, Bharatpur, Rajasthan (Samant *et al.* 1995). Only the bearded vulture *Gypaetus barbatus*, which is a typical mountain species, is not recorded from the Park. Four species are residents and three altitudinal migrants in the Park. The residents are the white-backed vulture *Gyps bengalensis*, long-billed vulture *G. indicus*, Egyptian vulture *Neophron percnopterus*, and king vulture *Sarcogyps calvus*. The Indian griffon *Gyps fulvus*, Himalayan griffon *G. himalayensis*, and cinereous vulture *Aegypius monachus* are altitudinal migrants.

The white-backed, king and Egyptian vultures regularly nest in the Park, whereas the long-billed nests at the nearest cliffs about 50 km

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southwest of the Park. The Indian and Himalayan griffons are uncommon winter visitors, seen in the Park from November to March. The cinereous vulture is seen occasionally, in winter.

All the species are scavengers and feed on the carcasses of large mammals, both domestic and wild. All the griffon vultures (*Gyps* species) are communal feeders and are seen in huge numbers on large animal carcasses (Ali and Ripley 1983). They are known to occur and breed in very high density near cities: a breeding density of 2.7 pairs per sq. km was recorded for the white-backed vulture in New Delhi (Galushin 1971). Prakash (1989) recorded a breeding density of 17 pairs per sq. km in Keoladeo National Park. The Egyptian and king vultures are usually solitary feeders, and feed on carcasses of smaller mammals, reptiles and fish.

The population of vultures was very high in India because of the unnatural food supply created largely by primitive methods of carcass and slaughterhouse waste disposal (Grubh 1989).

The Park falls in the semi-arid biogeographical zone (Rodgers and Panwar 1988). The vegetation of the area is a mixture of xerophytic and semi-xerophytic species consisting predominantly of *Acacia nilotica, Prosopis cinerea, Salvadora oleoides, Capparis decidua* and *C. sepiaria* (Prasad *et al.* 1996). According to Champion (1968) the vegetation of the Park can be described as Tropical Thorn Forest. This type of forest occupies a large part of western India which is not actual desert, western Punjab, Rajasthan, Kutch and Saurashtra, and a strip in southwest Madhya Pradesh running south to Bombay and east to Khandesh; Aurangabad south to northern Mysore and east to Guntur dist. in Andhra . This region has some of India's most productive agricultural areas, and a large proportion of the total livestock population. High concentrations of white-backed and long-billed vultures were seen in this area.

The land use pattern around the Park and the general landscape including vegetation type and structure represents the typical semi-arid agrarian ecosystem of the country. The Park could be considered broadly representative of semi-arid region. Hence, we could expect population trend of the white-backed vulture and long-billed vulture to be similar in most parts of the country to that of the Park.

Study Area

The Keoladeo National Park is situated at 27° 7.6'-27° 12.2' N lat. and 77° 29.5'-77° 33.9' E long., 2 km southeast of Bharatpur city and 180 km south of Delhi. It covers about 29 sq. km of flattish terrain sloping to a slight depression of about 8.5 sq. km in the centre. This forms the main submersible area of the Park and has been divided into several unequal compartments by dykes (Ali and Vijayan 1986). The Park gets water from an inundation reservoir situated about 500 m from the Park during June-July. Most of the waterspread areas dry up by March-April and the water remains in a few perennial water bodies. The inundation reservoir turns into an agricultural field after the water is released in the Park and for irrigation.

The average elevation of the area is 174 m. Extremes of climate are experienced with temperature varying between 1°C and 50°C. Apart from the wetland, the Park has *ca* 20 sq. km of woodlands, savanna-type grasslands and savanna with thickets. In some of the compartments, the marshes have scattered mounds planted with *Acacia nilotica*, and are also bordered with the same species, other tree species are *Mitragyna parvifolia*, *Sizygium cumini* and *Prosopis spicigera*. Agricultural fields of about 14 villages surround the Park. The major crops are mustard *Brassica campestris* and wheat *Triticum aestivum*. Pesticides are extensively used in the fields northeast of the Park in the water scarcity areas as they can become infested with white ants.

Study Period

The work was carried out as part of a Ph. D. programme during 1985-88, part of the project Ecology and Status of Resident Raptors in India, during 1990-92 and as a part of the ongoing project on the Effect of Environmental Contamination on Raptors during 1996-99.

Method

Population and Distribution of Vultures

The following standard methods (Fuller and Mosher 1981) were followed for estimating the population of vultures in the Park.

1. Road Transect Method

Roads and bunds were taken as transects and the birds were counted by driving slowly along the transect in the Park. An absolute count was attempted for all the species except for the white-backed and long-billed vultures. Their population was estimated during 1985-86 and 1986-87 as their number was very large and it was difficult to actually count all the birds. However, during rest of the years, the actual number was counted. All the sighting locations were marked on a map.

2. Nest Census

Nest searches were conducted once in a month throughout the Park for various species of vultures. The total count of the nests of white-backed vultures was carried out during February and March, when maximum nests are encountered.

3. Count at Carcasses

The number of vultures at large mammal carcasses was estimated whenever a carcass was observed.

Results and Discussion

1. **White-backed Vulture *Gyps bengalensis*: Population and Distribution**

The white-backed vulture is a resident of the Park and is sighted throughout the year. The population is usually low from June to September when most of the Park gets flooded, and there is hardly any habitat left for foraging. Its population gradually builds up, with the initiation of the breeding season in September when the pairs start occupying their old nests, and reaches a peak during March and April when the nestlings fledge and there is also an influx of birds from outside the Park. Food is available in abundance during this period as apart from the usual mortality of frail and old cows abandoned in the Park by villagers, a number of domestic cows perish on getting caught in the wet mud of the drying marshes, when they come to drink water.

A 96% decline in the maximum population was observed over the last one decade. During 1985-86 the highest population of 1800 vultures (density=62/sq. km) was recorded, whereas maximum of only 86 vultures were recorded during 1998-99 (density=3/sq. km) (Fig. 1).

The nesting population of the white-backed vulture also crashed by 95% over a decade. For instance, 353 pairs (nest density=12.17 nest / sq. km) were recorded nesting during 1987-88 but only 150 nests were recorded during 1996-97, 25 nests during 1997-98 and just twenty 20 (nest density= 0.68 nest/ sq. km) in 1998-99 (Fig 2).

During 1987-88, these vultures were observed throughout the Park, but they were seen only on the trees near the wetland in 1998-99.

Nesting Success

A sharp decline in the nesting success of the vulture was recorded over a decade. The nesting success was recorded as 82% (n=244) in 1985-86, but it was nil during 1997-98 (n=25) and 1998-99 (n=20).

During 1997-98, 60% of the nests were lost during nestling period (n=15), 20% were lost during incubation and in 20% nests (n=5) the birds failed to lay. During 1998-99, the birds did not lay in 60% (n=12) nests, nestlings died in 30% nests (n=6), and there was incubation failure in 10% (n=2) nests.

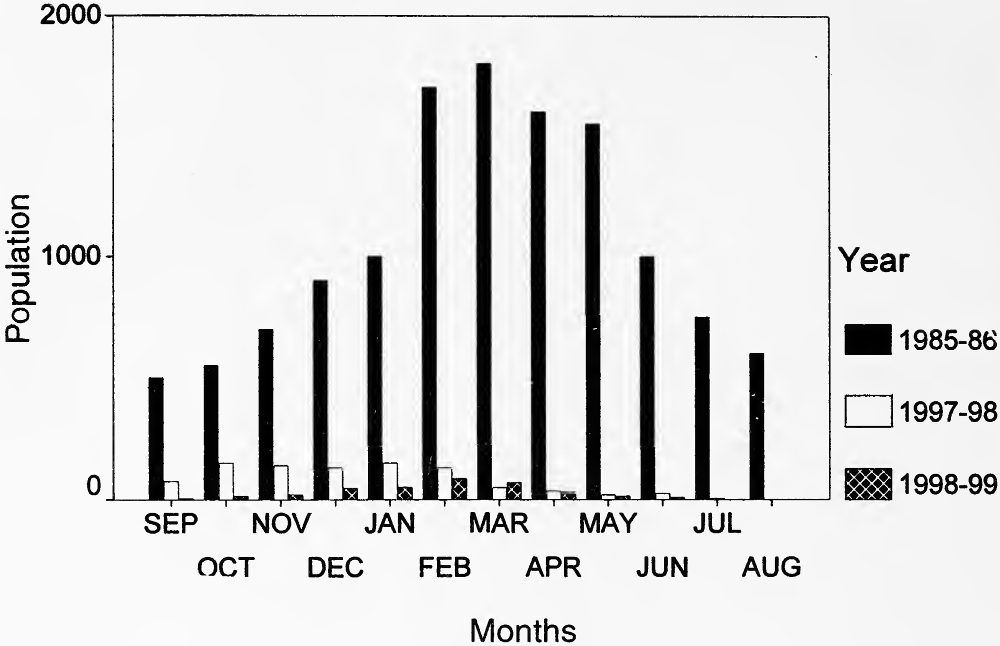

Fig. 1: Population of White-backed Vulture in KNP during various years

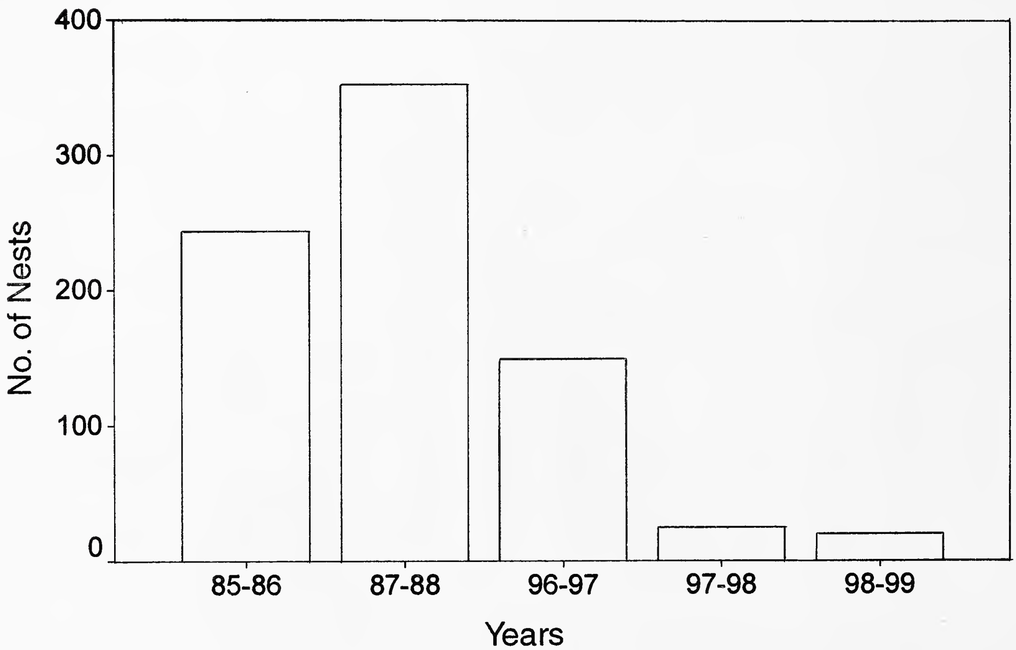

Fig. 2: Nests of White-backed Vulture in KNP during various years

Mortality

It is usually difficult to locate dead vultures, as they often die on large trees and quite often in secluded areas. Their carcasses are frequently seen entangled in the branches of trees or in thickets below the trees. Jackals also feed on the vulture carcasses. So, though vultures are big birds, their carcasses largely go unnoticed.

The birds were usually found dead on the nest, on trees or on the ground below the trees. Sporadic deaths were observed. Prior to death, individual vultures were seen perched on trees, dozing, with the neck slowly slumping down. They would wake up with a start, when the beak hit the branch. The bird usually remained in this condition for more than 30 days (n=5) and then would fall off the branch, sometimes getting caught in the branches of the trees and at times falling on the ground. The birds would die within minutes of falling down. The number of dead vultures must be far more than were recorded, due to various constraints.

High adult as well as juvenile mortality was recorded during 1997-98 and 1998-99, compared to 1985-86. Only 0.4 % mortality of total adult population (n=1800) was recorded during 1985-86, whereas it was as high as 1.5% of the total adult population (n=86) during 1998-99.

TABLE 1
MORTALITY IN WHITE-BACKED VULTURE RECORDED IN DIFFERENT YEARS

Year	Adult	Juvenile	Total No. of Nesting Pairs Recorded
1985-86	7	7	244
1987-88	10	1	353
1997-98	73	10	25
1998-99	9	6	20

2. LONG-BILLED VULTURE ***Gyps indicus***:

It is a resident and nests about 50 km southwest of the Park. It does not breed in the Park due to paucity of its nesting habitat, i.e. cliffs (Ali and Ripley 1983). The birds are,

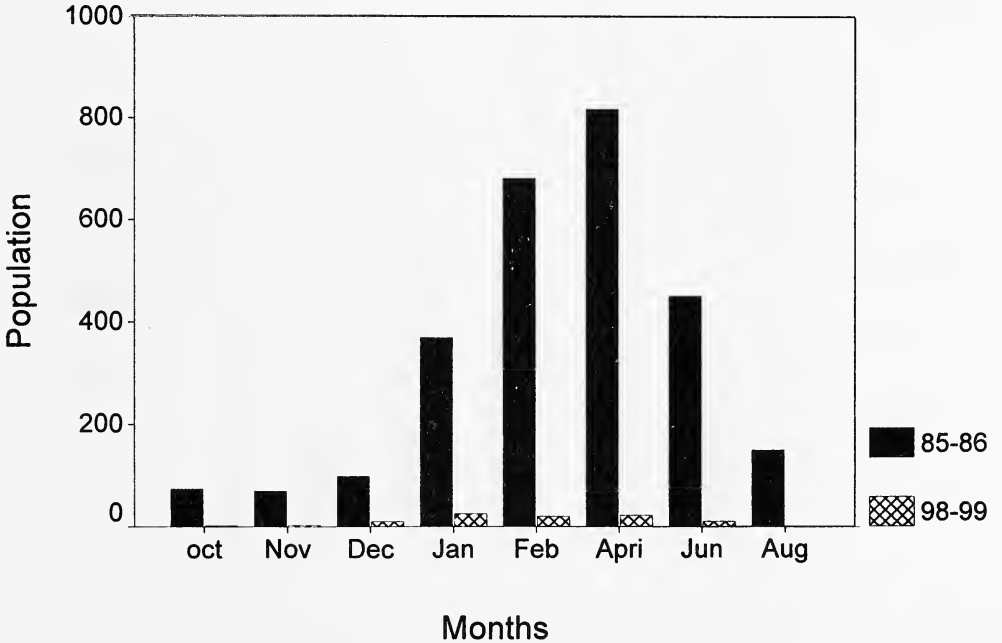

Fig. 3: Population of Long-billed Vulture in KNP during various years

however, seen in the Park throughout the year. Their number starts building up from November and the population reaches a peak in March-April.

The population of the long-billed declined by over 97% over a decade. A maximum of 816 birds (density=28 birds/sq. km) were recorded during 1985-86 but only 25 birds (0.86 birds/ sq. km) were recorded in 1998-99 (Fig. 3).

During 1985-86, on an average 80 vultures were sighted on a cattle carcass (n=13) of which 69% (n=79) were white-backed and 31% were long-billed. None of the carcasses were observed without vultures. However, during 1998-99, a total of 100 carcasses were sighted from November till May, but 92% were without any vulture and only eight (8%) had vultures feeding on them. On an average, 19 vultures were sighted on a carcass (n=8), of which 63% (n=12) were white-backed vultures and 37% (n=7) were long-billed vultures.

It appears that both the species have shown a drastic decline, but it is more pronounced in the white-backed vulture.

3. Indian Griffon ***Gyps fulvus***:

It is a winter migrant to the Park. 25-30 birds were observed wintering in the Park every year (Fig. 4). The population has shown a downward trend over the last decade. Only two birds were observed during 1997-98 and none during 1998-99. Despite the availability of food and much reduced competition from congenerics, the population of this species did not increase, but showed a drastic decline. Although the griffon is known to winter at a number of places in the Indian subcontinent, the drastic decline in population when food and habitat is available in abundance, could indicate a decline in its overall population.

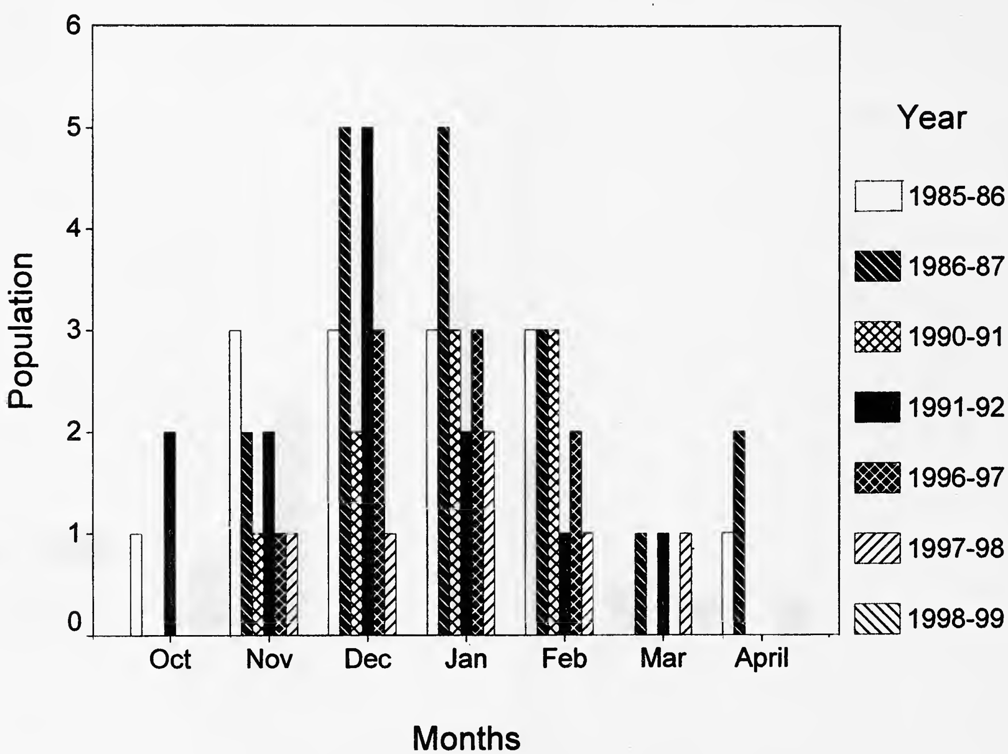

Fig. 4: Population of Indian Griffon in KNP

4. **Himalayan Griffon** ***Gyps himalayensis***:

It is an uncommon winter migrant to the Park. A few juveniles regularly wintered in the Park since 1985-86 (Fig. 5). No bird has been seen since 1996-97. The absence of the species from the Park, despite availability of food and habitat and near absence of competition for food from the congenerics, possibly indicates decline in the population of the species. A survey of the species in its known range will give a better overall picture.

5. **Egyptian Vulture** ***Neophron percnopterus***:

The population of Egyptian vultures fluctuated throughout the year in the Park. The highest population of vultures was seen during the months of April and May, when the water dried up and the birds came to feed on dying fish and turtle.

The breeding population of these birds has remained stable in the Park over the last ten years. Up to five pairs were recorded nesting during 1987-88, 90-91, 96-97 and 98-99. The vulture is largely a cliff nester and occasionally nests on trees. Absence of its preferred nesting habitat could be a limiting factor for its nesting population in the Park.

The population of the Egyptian vulture has also shown a decline, although there is very limited data on the population. Between 350 to 400 vultures were estimated during April 1986, whereas only 100-120 vultures were recorded during April 1998 and 25 vultures during April 1999. Their fall in number could be largely because of difference in food availability. Their number increases due to the drying up of water, as they come to feed on dead fish. However, the low breeding success of the bird is a cause of concern. Breeding has been nil during 1996-97 and 1997-98, while 50% success was recorded between 1985 and 1988. However, during 1998-99, 70% success was recorded.

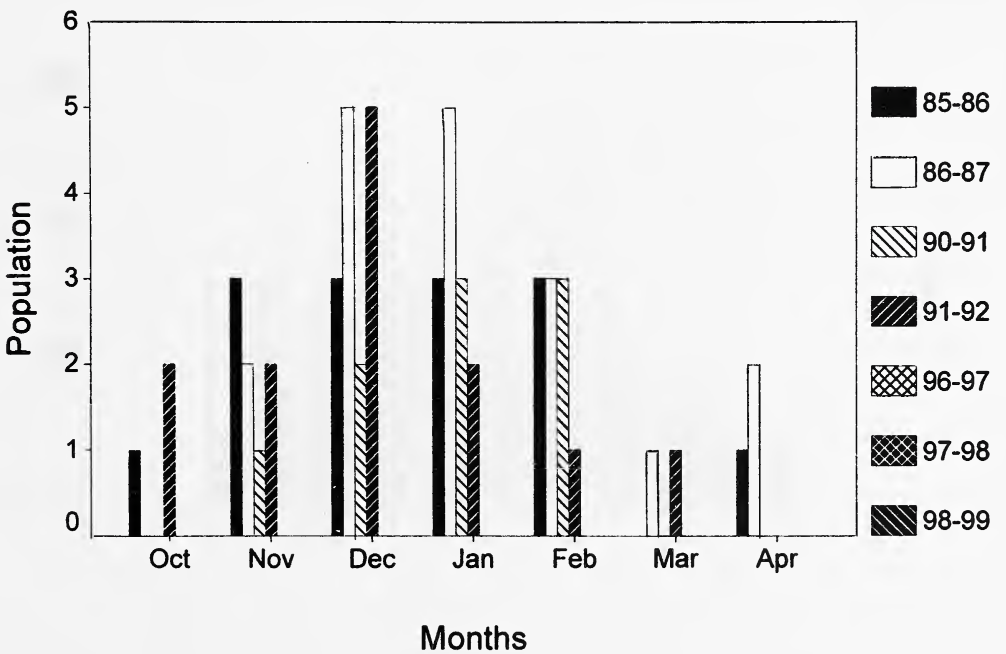

Fig. 5: Population of Himalayan Griffon in KNP in various years

TABLE 2
NESTING PAIRS OF EGYPTIAN VULTURE IN KEOLADEO NATIONAL PARK DURING VARIOUS YEARS

Year	No. of Nests	Nesting Success
1985-86	5	50 %
1986-87	5	50 %
1987-88	5	50 %
1990-91	2	No data
1996-97	3	0
1997-98	3	0
1998-99	3	70%

6. **KING VULTURE *Sarcogyps calvus***:

This is a resident species, seen in the Park throughout the year. Most of the adults and the fledged birds move out of the Park during the monsoon (July to September). The population starts building up and becomes highest in December-January. A fairly stable population of this species is seen in the Park. Over the last decade 4-5 pairs were observed (Fig. 6), and 3-4 pairs nest regularly (Table 3). Very few first year birds are sighted: perhaps all the young disperse out of the Park.

The nesting success has been erratic, but has been recorded low since 1991.

TABLE 3
NESTING PAIRS OF KING VULTURE IN KEOLADEO NATIONAL PARK

Year	No. of Nests	Ave. Clutch size	Nesting success
1985-86	3	1.33	0
1986-87	2	1	100 %
1987-88	3	1	100 %
1990-91	3	1	33.33 %
1996-97	4	1	Nil
1997-98	5	1	40 %
1998-99	3	1	100 %

7. **CINEREOUS VULTURE *Aegypius calvus***:

It is a rare winter visitor to the Park. Three birds were recorded during 1991-92 and were seen throughout the winter. The bird is a common visitor to western Rajasthan in the desert areas.

OBSERVATIONS AND DISCUSSION

Population Crash in *Gyps* species

All species of *Gyps* vultures have shown a sharp decline in their population. All the species

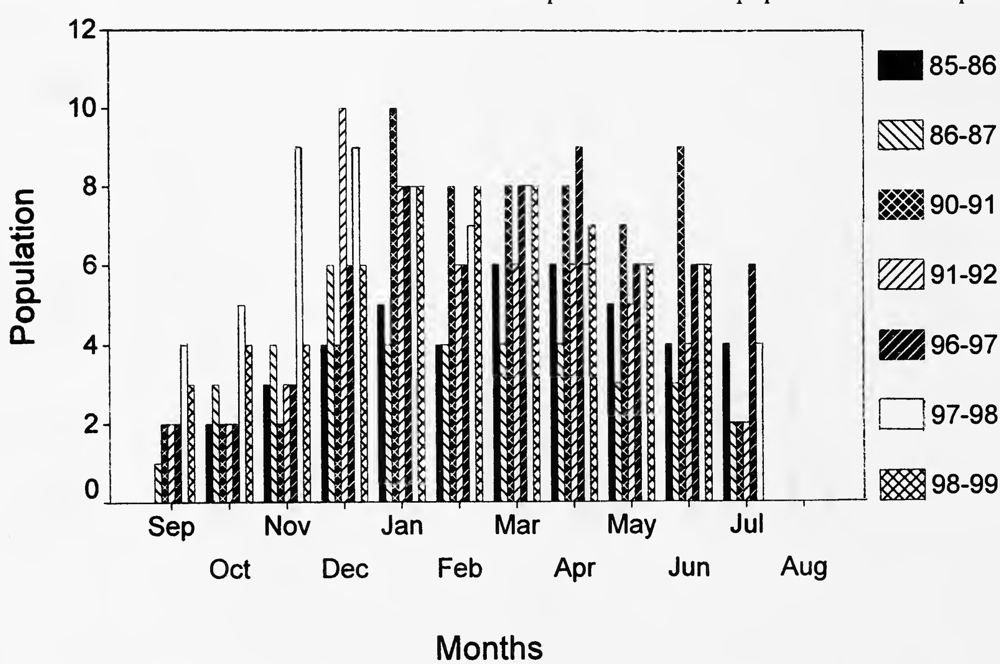

Fig. 6: Population of King Vulture in KNP during various years

are communal feeders and are known to feed on the carcasses of the larger mammals.

There has been a very steep decline in the population of white-backed and long-billed vultures. The population of white-backed has declined by 96% and that of long-billed vulture by 97% over a decade in the Park. (Figs. 1 & 3). High adult mortality (Table 1) and total breeding failure have caused the population decline.

Vultures are long-lived birds and together with the albatross have the lowest reproductive rate of any bird species in the world (Lack 1968). It follows that their mortality rates must be among the lowest of any bird species. The studies on large tropical seabirds suggest that the adult survival rates of 95 to 97% may not be uncommon (Houston 1979). If adult mortality becomes heavier the birds cannot compensate by increasing their rate of reproduction, and the species slowly declines to extinction. Computer models show that for vulture populations it takes only a relatively small annual increase in adult mortality to lead to rapid population decline (Houston 1987). The crash in vulture population by over 96% due to high adult mortality and almost zero breeding success can well lead the white-backed vulture to extinction.

The population of all the *Gyps* vultures appears to have crashed. The population of long-billed vulture has also declined by 97% (Fig. 3). This was the second most abundant species in the Park. The bird does not breed in the Park, so there is no data on its breeding. The presence of 25-30 carcasses every month and the absence of *Gyps* species, 92% of the time (n=100), both during summer and winter, suggest a crash in population of both the residents i.e. white-backed and long-billed vultures and migratory i.e. Indian griffon and Himalayan griffon vultures. There has been complete absence of Indian griffon and Himalayan griffon in the Park during 1998-99, even though food was available in abundance. The Himalayan griffon was also not seen during 1997-98.

The breeding population of the king and Egyptian vultures has remained fairly stable over the years. This appears to be the normal situation elsewhere, with the population of large and long lived raptors (Newton 1979). Large birds, especially raptors, have greater immunity from predation and an increased ability to survive temporary food shortages. The larger the bird, the more consistently is its population likely to remain close to the level that the environment will support (Newton 1979). The stability of the population does indicate stable ecological conditions for the species. Incidentally, both the king and Egyptian vultures feed more on smaller carcasses and occasionally on large mammal carcasses. They usually remain either solitary or in pairs. They are seldom seen feeding in flocks.

To investigate the major causes of decline in the population of *Gyps* vultures, the ecological factors, which could have caused major changes in the population, were examined:

1. *Food Supply*: Reduction in the size of the food supply has undoubtedly been a major factor in the recent decline of some vulture populations, particularly the European and South African species (Houston 1974). Food does not appear to be a cause of decline as it is still available in abundance. Every month 20-25 carcasses are seen in the Park, with very few or no vultures on them. It takes days to finish off a carcass. There has been no change in the method of carcass disposal by the villagers around the Park. The carcasses of cattle are skinned and thrown out into the open.

2. *Nesting and Perch Site*: Raptors are among the few groups of birds whose numbers and nest success are in some region clearly limited by the availability of nesting places (Newton 1979). Reduction in the availability of perch and nesting sites can cause population decline. The paucity of good nesting sites can severely reduce breeding success. The vultures are big birds, which weigh about 4-5 kg and hence need big and strong trees for nesting. There

has been a general decline in the number of old and mature trees, but not so severe as to cause a crash in vulture population. Although we do not have hard data on the nesting tree availability, there has been no marked decline in number of big trees for nesting. Anyway, it cannot lead to the steep decline seen in white-backed vultures.

3. *Effect of Pesticides and Insecticides*: The sharp fall in raptor population with the increase in the use of pesticide is well known (Ratcliff 1967, Hickey and Anderson 1968, Hickey 1969). Persistent, high fat solubility and sub lethal effects are the main qualities, which lead organochlorine pesticides to cause decline in bird population. Predators and scavengers at the top of the food chain are among the most affected species (Newton 1984) as they are especially liable to accumulate organochlorines in large amounts. At sublethal levels of only a few ppm in tissues, organochlorines can disrupt the breeding of certain birds (Newton 1984).

In India, organochlorine pesticides are extensively used in agriculture. This group includes DDT and cyclodienes such as aldrin, dieldrin, endrin and endosulphan. A survey of pesticide use around the Keoladeo National Park revealed extensive use of organochlorine compounds including aldrin, dieldrin, endosulfan and heptachlor. The use of aldrin has become very restricted as it is banned and is not available in the market. DDT, which has been banned for use in agriculture, is still extensively applied after being diverted from the National Malaria Control Programme. Lethal levels of DDE, aldrin and dieldrin were detected in the tissues of sarus crane *Grus antigone* and ring dove *Streptopelia decaocto,* but negligible levels were found in greylag geese *Anser anser* in Keoladeo National Park (Vijayan 1991). DDE, the main metabolite of DDT, causes shell thinning and egg breakage as well as embryo death in intact eggs. Different species of raptors show little variation in their response to DDE, but raptors in general are more sensitive to a given level of DDE than birds in other families. Aldrin and dieldrin are more toxic than DDT, and cause mortality of both adults and embryo. Increased mortality led to very rapid population declines of sparrowhawk *Accipiter nisus* and peregrines *Falco peregrinus* in Britain (Newton 1979).

Circumstantial evidence suggests that the population decline in vultures could have been caused by the lethal and sublethal intake of pesticide through food. The vulture population has shown symptoms of pesticide contamination like breeding failure due to non-hatching, breaking of eggs in the nest, failure to lay and death of nestlings. High adult mortality is also recorded.

It is, however, not clear how vultures ingest such a high dose of pesticide, which causes direct mortality and total breeding failure. The white-backed and long-billed vultures feed mainly on the carcasses of large mammals. Among the raptors in any given area, mammal eaters invariably contained lower organochlorine levels than bird eaters or fish eaters (Conrd 1977, Henry 1977, Newton 1979). In addition, mammals in general are better able to metabolise organochlorines than are birds. Birds and fish have higher levels of contamination than herbivorous mammals (Cooke 1973, Stickel 1975). There was less concern for raptors or avian scavengers which feed mainly on mammals, since it was presumed that they would not accumulate as high a body burden of organochlorine (Lockie *et al.* 1969).

There has been no noticeable decline in the breeding success of fish eating birds or their population in the Park. The population of other raptors including vultures other than *Gyps* species, which largely feed on fish, amphibians and reptiles, has also not shown any drastic decline. As should be expected, based on the studies carried out elsewhere (e.g. Cooke 1973, Conrd 1977), fish eaters and bird eaters should get affected earlier than the raptors feeding on mammals. It may be that vultures metabolise

pesticides differently than other groups of birds, resulting in greater concentration. The Andean condors *Vultur gryphus* collected in Peru had much higher concentration of chlorinated hydrocarbons than other local species including the brown pelican *Pelecanus occidentalis*, which is known to concentrate pesticide. In contrast, golden eagles, with a food source similar to condors, have shown no significant eggshell thinning (Hickey and Anderson 1968) or bodily concentration of pesticides (Reichel *et al.* 1969). Due to a different metabolism, the vulture accumulates pesticides faster than other species (Snyder 1986). *Gyps* vultures could also have accumulated pesticide faster than other bird species in a similar process. High residual level of DDE was detected in the eggs of California condor *Gymnogyps californianus* (Jarman and Risebrough 1986), Eurasian griffon (Mendelssohn 1972), and cape vulture *Gyps coprotheres* (Wyk *et al.* 1993) but the source of DDT is still not confirmed (Kiff 1989). All three species also scavenge mammalian carcasses like the white-backed vulture. The few vulture tissue samples from the Park analysed so far have, however, not shown any significant load of pesticide. (Bhagwat, A.M., C. B. Patel Institute, Vile Parle, Mumbai, pers. comm. 1999).

Breeding failure could be due to organochlorine contamination in the tissue, but the cause of adult mortality is still not clear. There have been no observations of large-scale deaths of vultures after feeding on a carcass. Mortality has been sporadic and widespread.

4. *Poisoning*: Vultures are far more susceptible to poisoning than any other bird of prey, for the obvious reason that they may not be able to distinguish a dead animal that contains poison (Houston 1987).

Carcass poisoning in and around the Park was not observed. No large-scale mortality has been observed in vultures after consuming meat from the carcass. There have been instances of village cows dying after deliberately being fed on rodenticide zinc phosphide by hide collectors. No mortality was seen after vultures fed on the poisoned carcasses. Thus poisoning does not seem to be a major cause of decline in vulture population. Strychnine poisoning of carcasses by farmers was identified as a major cause of population decline of Cape vulture (Dobbs and Benson 1984). There have been reports of deliberate poisoning of carcasses to kill wild animals such as jackal *Canis aureus*, wolf *Canis lupus*, leopard *Panthera pardus*, tiger *Panthera tigris* and lion *Panthera leo*, whenever these animals are suspected to have attacked the cattle and sheep in different parts of the country. Mortality of vultures after feeding on poisoned carcasses has been reported (Grubh 1974). Such incidents are few and far between and cannot be the cause of population crash in vultures.

5. *Changes in Genetic Diversity of the Population*: All biologically important characteristics of populations including their size and reproductive efficiency are determined by historically established gene pool (Wyk *et al.* 1993). Depression of fitness traits, such as survival and fecundity, which are components determining breeding success may be associated with low levels of heterozygosity (Leberg 1990). Fluctuation in the size of breeding populations can be accompanied by a reduction in the genetic variability (Eitniear 1989) which in turn reduces the ability of a species to adapt to environmental changes (Meffe 1990). In the current situation, the lack of genetic heterozygosity could be indicative of the abovementioned negative factors for white-backed vulture. Low levels of genetic variability were reported in *Gyps coprotheres* in South Africa and this was considered to be a major reason for the drastic population decline in the once abundant *G. coprotheres* in South Africa (e.g. Wyk *et. al.* 1993). No studies have been carried out on the *Gyps* species on genetic variability in India. Low level of genetic variability, coupled with some other factors, could be a cause of population decline.

6. *Outbreak of Disease*: According to Newton (1979) disease plays an insignificant role in the control of raptor populations, and accounts for only a small part of the total mortality. However, disease is not rare in raptors and has caused mortality. The typical symptoms displayed by birds suffering from pesticide contamination like increased aggression, reduced discriminatory behaviour and alertness, poor incubation and reduced territorial activity were not evident in the sick vultures in the Park. Vultures also have unusual resistance against disease (Kalmbach 1939, Singh, R. B. pers. comm.) There is still a possibility of a viral disease, which has probably caused the widespread mortality in the adults and juveniles. The birds appear sick before they die. They perch on a branch, appear drowsy and frequently doze off with the neck limp and hanging. The vulture wakes up with a start and pulls up the neck. After a while, the neck becomes limp again, and the same sequence is repeated. The bird remains at the same place for about 32 days (n=5) and then falls on the ground and dies. They can fly short distances while they are sick.

7. *Calcium Deficiency*: Calcium deficiency is thought to cause problem in the chick skeleton development and causes chick mortality. Evans and Piper (1981) estimated that approximately 20 % of all cape vulture chicks were affected by nutritional bone disease. The authors postulated that the necessary calcium for chick development was inadequate and directly related to the declining population of bone crunching hyenas (Mundy and Piper 979). The population of hyenas has also declined with the spread of human population in India. Some chick mortality in the country could be due to calcium deficiency. But this needs to be investigated further. Dobbs and Benson (1984), however, found that bone abnormalities in growing cape vulture were not caused by inadequate calcium intake and the vulture gets adequate calcium from the food. So calcium may not be a cause of decline in vulture population.

Conclusions

There has been a crash in population of *Gyps* vultures in Keoladeo National Park over a decade. The white-backed vulture has suffered large-scale adult mortality and total breeding failure. The long-billed vulture has also suffered a population decline of over 97%. The Indian griffon and Himalayan griffon have also experienced drastic fall in numbers. The non-*Gyps* species of vultures have maintained fairly stable population over the years.

The exact cause of the population crash is not clear. Circumstantial evidence suggests pesticide contamination to be the major cause of decline. However, the high adult mortality could not be explained by pesticidal contamination alone. The decline in genetic variability could have made the vulture population susceptible to disease, which caused high adult mortality and breeding failure. Intensive efforts are required to determine the cause of decline in vulture and effective conservation measures should be taken to save the species from extinction.

Recommendations for saving *Gyps* species from imminent extinction

The population of white-backed vulture has declined because of adult mortality and almost total breeding failure. The population of other *Gyps* species vultures is feared to be facing a similar fate. There is no definite clue to the causes of adult mortality and total breeding failure. The following steps should be taken to save these vultures from imminent extinction:

i. Pilot survey of vulture populations all over the country especially in areas where data on vulture populations exists, to find out the extent of population decline.

ii. Tissue samples of vultures and their food should be analysed on a large scale in different parts of the country to estimate the load of organic pesticides, specially organochlorines in the tissues.

iii. Genetic studies should be initiated to see if there is decline in genetic diversity.

iv. Pathological studies should be initiated immediately to find out if any disease is responsible for the crash in vulture population.

v. Captive breeding programme should immediately be taken up to save the species from extinction. A 96% decline in population and total breeding failure can certainly cause extinction.

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ABUNDANCE AND DISTRIBUTION OF MOTHS OF THE FAMILIES SATURNIIDAE AND SPHINGIDAE IN SANJAY GANDHI NATIONAL PARK, MUMBAI[1]

V. Shubhalaxmi and Naresh Chaturvedi[2]

(*With five text-figures*)

Key words: Saturniidae, Sphingidae, Lepidoptera, abundance, distribution, Sanjay Gandhi National Park

In order to study the ecology of moths belonging to Families Saturniidae and Sphingidae, a three-year study was conducted in Sanjay Gandhi National Park, Borivali, Mumbai. During the study, two species of Saturnids and sixteen of Sphingids were recorded. Range extension for four species of Family Sphingidae was recorded. Abundance ratio cf Sphingids and Saturnids was found to be 80:20. It was observed that the activity of moths begins in the early monsoon, reaches a peak in mid-monsoon, and is slowly reduced by the end of post-monsoon. The abundance of these moths was greatly dependent on the availability of the foodplants. During monsoon, all the foodplants were in full foliage; therefore the maximum abundance of all the species was recorded in this season.

Introduction

Species richness of moths in India is related to heavy rainfall, high floristic diversity, whereas arid and semi-arid regions with low floristic diversity have a smaller number of species. Hence, some of these moths can be termed as Indicator Species. Earlier studies on moths emphasized their taxonomy, and very little is known about their ecology, except for some pest species.

Sanjay Gandhi National Park (SGNP), the study area is among the very few national parks in India which are surrounded by a metropolis like Mumbai. It is constantly under heavy biotic pressure from humans. This national park forms part of the Western Ghats, a crucial area with rich biodiversity. Though most of the flora and fauna is well documented, very little is known about the insect fauna of the park area.

Family Saturniidae

The Saturniidae are known as Emperor Moths or Non-mulberry silkmoths (Arora and Gupta, 1979). The Atlas moth is the largest moth in the world, having a wingspan of 33 cm (Kehimkar, 1997). Others like Tussar, Muga and Eri moths are known for their silk producing capacity and are commercially exploited by the silk industry.

Nearly 40 species are found in India (Arora and Gupta, 1979), mostly confined to the moist forests and plains. The adults are brightly coloured with hyaline patches on their wings. The males are smaller than the females and have feathery antennae, while females have narrow antennae. The caterpillars are robust, distinctly segmented, often with sparse hairs and tubercles. The cocoons are large, of fine or coarse silk, either oval, attached to a twig by a silken peduncle, or elongated, woven loosely among the foliage.

Family Sphingidae

The Sphingidae are known as Hawk moths. They are known to travel long distances on migration; some have even been encountered at mid-sea by ships (Kehimkar, 1997).

According to Imms (1957) there are 1000 species existing throughout the world. Nearly 200 species are recorded from India (including Andamans), Myanmar and Sri Lanka, out of which 134 species are known to occur in the Eastern Himalaya alone (Beeson, 1941). The

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stout, cigar-shaped body and long, narrow forewings of the adults are distinctive. The very long proboscis makes hawk moths ideal pollinators for flowers with long tubular corolla (Barlow, 1982).

Study Area

The SGNP is situated in Greater Bombay and Thane districts, occupying 44.50 sq. km and 58.64 sq. km respectively. The total area of the park is approx. 103 sq. km. It is situated about 40 km to the north of Mumbai city and about 8 km from the Arabian Sea. It has four types of habitats ranging from mangroves to the evergreen forests of Western Ghats. Most of the trees are deciduous and at places evergreen. The forest has a diversity of flora ranging from the tallest trees to ground layer shrubs and herbs.

Apart from the SGNP area, the study was also carried out on the adjoining 1.5 sq. km land of the Bombay Natural History Society (BNHS) at Goregaon. The vegetation of the BNHS land is of southern moist-mixed deciduous type, and the topography is mainly hilly intersected with rocky streambeds. There are seasonal rainfed streams.

Materials and Methods

Weekly field visits were conducted from January 1994 to December 1997 in different parts of the study area. Besides observing the caterpillars in the wild, a few caterpillars of each species were reared in captivity.

The caterpillars were usually located on their foodplants. Half-eaten leaves or fully defoliated branches gave clues to their presence. In some species, caterpillars were found on the underside of the leaf, whereas some were seen resting alone on the defoliated branch. Newly hatched caterpillars were found on clusters of young leaves of the foodplant. Frass particles below the foodplant were also helpful in spotting caterpillars. The size of the frass particles was useful in estimating the approximate instar of the feeding caterpillar.

Eggs and caterpillars collected from wild were reared in the laboratory. The egg bearing leaf was kept fresh by removing all other leaves from the stem and then it was placed in a bottle with water. The narrow neck of the bottle was plugged with cotton. The stem was then covered by a plastic bag secured by a rubber band at the neck of the bottle.

Newly hatched caterpillars were transferred to fresh foodplants with tender leaves, placed in plastic containers having perforated lids. Tissue paper was placed at the bottom of the container to absorb moisture from frass collected in the jar. This kept the jar dry for longer periods, preventing fungal, bacterial and viral infections. Fresh leaves were given every morning and evening. Usually the container was cleaned every morning. However, when caterpillars were nearing final instar, they became voracious feeders and the containers had to be cleaned twice a day. In order to provide protection from ants, the containers were placed in a plate filled with water. While the foodplants were collected, a careful search was made to remove predators like spiders and ants, and the plants were stored in a refrigerator.

Detailed notes on the appearance of the caterpillar and measurements were taken of each instar. Behavioural aspects and effects of climatic factors were also studied and noted. As the caterpillar reached maturity, pupation sites were prepared for those pupating under the soil or amongst the leaf litter inside a big plastic jar. In case of doubt, both options were provided. A few twigs were placed in the jar for the emerging moth to climb up and dry its wings. To make a representative collection, adults of each species were killed in a killing jar using ethyl acetate.

To study the species' attraction to light and also to make a checklist of moths, light traps were set up in the study area. However, due to rainfall and unsuitable locations, these attempts

were not very successful. Based on the specimens collected and field observations, the abundance and distribution have been studied.

Results

A. Moth Activity

It was observed that moth activity was greater during the monsoon and post-monsoon period, when larval foodplants were available in abundance. With ample food resources, egg laying was at a peak. Abiotic factors such as rainfall, temperature and humidity played a vital role in influencing the distribution and abundance. Moth activity began by early monsoon season and reached a peak level in mid-monsoon season, slowly decreasing, by the end of post-monsoon period.

1. Rainfall: In Mumbai, normal precipitation reaches about 2600 mm p.a. as per data obtained from the Meteorological Department, Santacruz, Mumbai, (Table 1). The mean monthly rainfall for three years showed that maximum rainfall was received during July, while the monsoon begins from June and ends in October. A correlation was drawn between the rainfall and moth activity (Fig. 1). It showed that though the maximum rainfall (87 mm) was received in July, the moths were found to be active from April onwards. The moth activity progressively increases till August, and reached a peak, while the rainfall had reduced to 43 mm. From September onwards there was a gradual decrease in the moth activity till the coming April.

2. Temperature: It was observed that fluctuation in maximum temperature was nearly 4°C, whereas the fluctuation in minimum temperature was approximately 10°C, more than twice that of maximum temperature (Table 1). Rise in temperature was observed from March onwards till November except in August and September. The correlation between the moth activity and the temperature (Fig. 2) showed that fluctuation among maximum and minimum temperature was low during August and September, which leads to a peak level in moth activity.

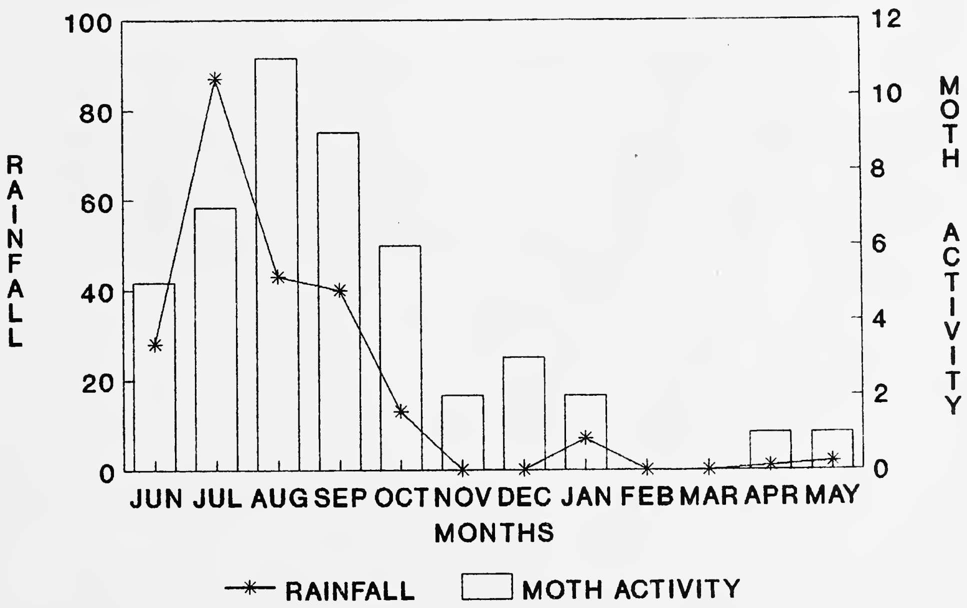

Fig. 1: Rainfall / activity of moths (1994-96)

TABLE 1
MEAN MONTHLY CLIMATIC FACTORS (1994-97)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	07	0	0	01	02	28	87	43	13	0	0	0
Temperature (°C)												
Max.	30	31	33	33	34	33	31	30	30	33	33	31
Min.	17	18	22	24	27		26	26	25	24	21	18
Humidity (%)												
Max.	86	88	86	88	83	89	95	92	92	90	85	88
Min.	26	25	32	38	54	68	75	72	66	39	28	27

3. Humidity: Being close to the Arabian Sea, the study area is always humid. The data on humidity (Table 1) showed that the maximum humidity was never less than 85% and the minimum humidity was always more than 25%. The rise in humidity was observed from June to October whereas the decline was from November to May. The effect of humidity on moth activity was analysed (Fig. 3). It showed that fluctuation between maximum and minimum humidity was low during July and August. Moths preferred high humidity levels for their activity.

Hence, it was concluded that for peak level in moth activity, the optimum requirements were rainfall 43 mm, humidity 92% and temperature 30 °C. These conditions were achieved in August. This relation has been drawn from Figs. 1, 2 & 3.

B. Abundance

Out of the 40 recorded species of Saturniidae and 181 species of Sphingidae in India, 2 Saturnids and 14 Sphingids were studied. The analysed data on moth species (Figs. 4 and 5)

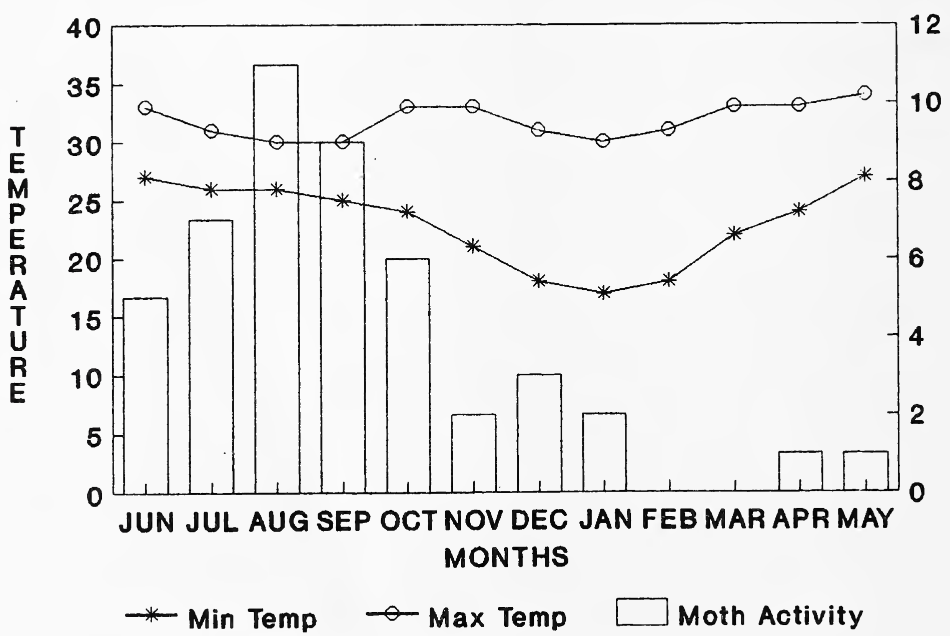

Fig. 2: Temperature / activity of moths (1994-96)

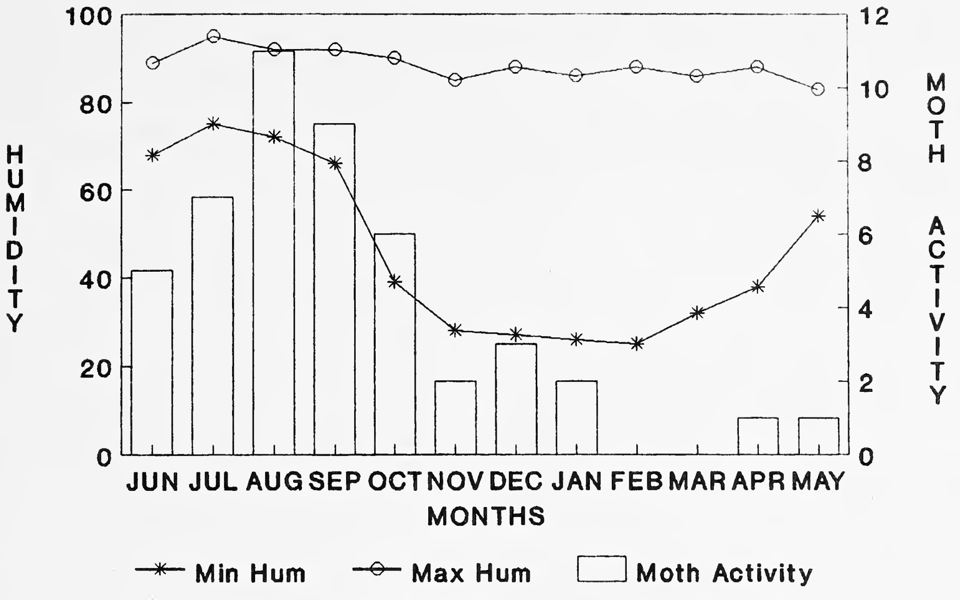

Fig. 3: Humidity / activity of moths (1994-96)

shows the abundance of individual species as well as the abundance component of each Family as percentage of the total number of species.

From Fig. 4, it was concluded that among the Saturnids, *Antheraea paphia* was more abundant than *Actias selene*. However among Sphingids, *Macroglossum gyrans* had the highest abundance. The next species among Sphingids was *Theretra lycetus*, which has the second highest abundance, but within restricted period. This was followed by *Nephele didyma, Marumba dyras* and *Cephanodes hylas*, and the remaining ten species (1 Saturnid, 9 Sphingids) form a minor share, hence they are categorized as 'Others' in Fig. 4.

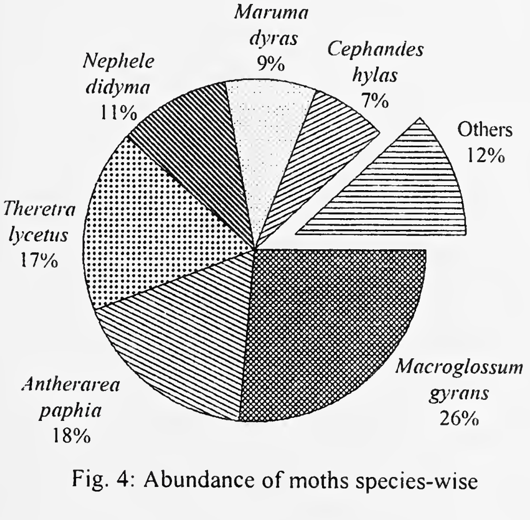

Fig. 4: Abundance of moths species-wise

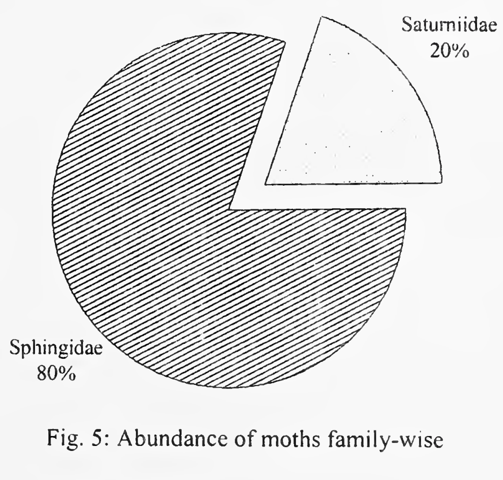

Fig. 5: Abundance of moths family-wise

TABLE 2
MONTHLY DISTRIBUTION OF MOTHS (1994-97)

Moth Species	No.of Moths	Months
Family Saturniidae		
1. *Actias selene*	02	Jul, Aug
2. *Antheraea paphia*	05	Jun, Jul, Aug, Sep, Oct
Family Sphingidae		
Subfamily Sphinginae		
1. *Acherontia lachesi*	02	Jul, Aug
2. *Acherontia styx*	01	Apr
3. *Clanis phalaris*	02	Jun, Jul
4. *Polyptychus dentatus*	02	Oct, Dec
5. *Marumba dyras*	03	Jul, Aug, Sep
Subfamily Macroglossinae		
11. *Cephanodes hylas*	04	Jun, Jul, Aug, Sep
12. *Nephele didyma*	07	Jun, Jul, Aug, Sep, Oct, Nov, Dec
13. *Gurelca hyas*	03	Jun, Aug, Oct
14. *Macroglossum gyrans*	20	Jan, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec
15. *Macroglossum belis*	05	Jan, Jun, Jul, Sep, Dec
16. *Theretra nessus*	01	Sep
17. *Theretra clotho*	03	Jul, Aug, Sep
18. *Theretra alecto*	01	Aug
19. *Theretra lycetus*	04	Jul, Aug, Sep, Oct
20. *Theretra oldenlandiae*	01	Jun
21. *Rhyncholaba acteus*	01	Sep

From Fig. 5, it was concluded that the abundance of Sphingids was much higher than that of Saturniidae, the abundance ratio being 80:20.

C. Range Distribution and Occurrence

The range distribution and occurrence period of moth species is mentioned below. The range distribution pertaining to the Indian subcontinent is as described by Hampson (1892-96), Beeson (1941), Arora and Gupta (1979) and Barlow (1982). The details of occurrence are as per the data collected and presented in Table 2.

a. Family Saturniidae

The Saturnids are widespread over the moist hill forest areas in India, often at low elevations, but they are typically subtropical and only occasionally are they plains species (Beeson, 1941). Out of the 40 recorded species from India, two species were recorded from the study area.

1. ***Actias selene*** (Hubner)

Distribution: The species is widely distributed throughout India, Nepal, Bhutan, Bangladesh, Myanmar, Sri Lanka. Occurrence period: July-August. Foodplant: *Lannea coromandelica*, a deciduous tree that bears new leaves in monsoon.

2. ***Antheraea paphia*** (Linnaeus)

Distribution: The species is restricted to moist hill forest areas and plains. Found throughout India, Pakistan, Bangladesh, Sri Lanka, Nepal, Bhutan, Myanmar in suitable habitat. Occur-rence period: June-October. Foodplant: *Zizyphus mauritiana, Terminalia crenulata, T. bellerica, Anogeissus latifolia* and *Bridelia retusa*.

b. Family Sphingidae

The Sphingids are mostly confined to hilly areas and plains. Out of the 181 species recorded

for India, 16 were recorded from the study area.

Subfamily Sphinginae

1. ***Acherontia lachesis*** (Fabricus 1798)

Distribution: Throughout India, Sri Lanka. Occurrence period: July and August. Foodplant: *Ipomea carnea*, a perennial climber.

2. ***Acherontia styx*** (Butler 1876)

Distribution: Throughout India, Sri Lanka. Occurrence period: April. Foodplant: *Ipomea* sp.

3. ***Clanis phalaris*** (Hubner 1818)

Distribution: It is mainly found in eastern India, in Sikkim and extralimitally in Malaya. The present record from Mumbai is a range extension. Occurrence period: June and July. Foodplant: *Pueraria tuberosa,* a perennial climber.

4. ***Polyptychus dentatus*** (Cramer 1818)

Distribution: Old Bombay State, West Bengal, Eastern and Northwest Himalaya. Occurrence period: October and December. Foodplant: *Cordia dichotoma*, a deciduous tree.

5. ***Marumba dyras*** (Butler 1875)

Distribution: The known distribution range was Northwest and Eastern Himalaya, Assam, Karnataka, Andamans and Sri Lanka, and the present record is a westward range extension. Occurrence period: July- September. Foodplant: *Bombax ceiba, Firmania colorata, Helicteres isora* and *Grewia tiliaefolia.*

Subfamily Macroglossinae

1. ***Cephanodes hylas*** (Linnaeus 1771)

Distribution: Throughout Indian subcontinent. Occurrence period: June to September. Foodplant: *Mitragyna parvifolia, Hymenodictyon orixense, Haldina cordifolia, Gardenia lucida, G. grandiflora* and *Pavetta indica.*

2. ***Nephele didyma*** (Fabricius 1775)

Distribution: Throughout India, Sri Lanka. Occurrence period: June to December. Foodplant: *Carrisa carandas*, an evergreen shrub.

3. ***Gurelca hyas*** (Walker 1856)

Distribution: This record is a range extension and a new record for Mumbai. The known habitat range was Sikkim and Bangladesh. Occurrence period: June to August. Foodplant: *Morinda tinctoria* var *tomentosa*, an evergreen tree.

4. ***Macroglossum gyrans*** (Walker 1856)

Distribution: Throughout India, Sri Lanka. Occurrence period: June to September. Foodplant: *Morinda tinctoria* var *tomentosa*, an evergreen tree.

5. ***Macroglossum belis*** (Cramer)

Distribution: Throughout India, Sri Lanka, China. Occurrence period: January, June, September, and December. Foodplant: *Morinda tinctoria* var *tomentosa*, an evergreen tree.

6. ***Theretra nessus*** (Drury 1773)

Distribution: Throughout India, Sri Lanka, Myanmar. Occurrence period: September. Foodplant: *Dioscorea sp.*

7. ***Theretra clotho*** (Drury 1773)

Distribution: Throughout India (including Andamans), Sri Lanka, Myanmar. Occurrence period: June to September. Foodplant: *Ampelocissus latifolia*, a seasonal monsoon climber.

8. ***Theretra alecto*** (Linnaeus 1758)

Distribution: Throughout India, Sri Lanka, China. Occurrence period: August. Foodplant: *Ampelocissus latifolia*, a seasonal monsoon climber.

9. ***Theretra lycetus*** (Cramer 1775)

Distribution: This record is a range

extension for Mumbai; the earlier records were from Mussoorie, Sikkim, Sri Lanka. Occurrence period: July to October. Foodplant: *Leea asiatica* and *L.macrophylla*, a seasonal monsoon herb.

10. ***Theretra oldenlandiae*** (Fabricius 1775)

Distribution: India. Occurrence period: June. Foodplant: *Ampelocissus latifolia*, a seasonal monsoon climber.

11. ***Rhyncholaba acteus*** (Cramer 1779)

Distribution: India. Occurrence period: September. Foodplant: *Amorphophallus commutatus, Leea asiatica*, seasonal monsoon herbs.

Discussion

Environmental factors such as rainfall, temperature and humidity are important as they influence the distribution and abundance of insects and their food plants under study (William, 1987). The study showed that two families of moths have considerable ecological variations. The moths of family Sphingidae are eight times as abundant as the family Saturniidae. This coincides with the overall pattern recorded in India, Saturniidae as such comprises of fewer species i.e. 40 and Sphingidae has nearly 181 species. It was also observed that while the distribution range and occurrence of the two families vary, there is some overlapping of distribution range. Saturnids are mostly confined to moist hill forests, whereas Sphingids occur in forests as well as in plains. This being a subtropical group, it is distributed widely in diverse habitats. It was found that four species of Sphingidae had range extension for the study areas, as the earlier known range for *Clanis phalaris, Marumba dyras, Gurelca hyas* and *Theretra lycetus* was only northeast India.

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STATUS OF DIURNAL RAPTORS OF CORBETT NATIONAL PARK WITH NOTES ON THEIR ECOLOGY AND CONSERVATION[1]

RISHAD NAOROJI[2]

(*With one map*)

Key words: Raptors, status, conservation, checklist, Corbett National Park, Uttar Pradesh, India.

Out of a total of 69 species of diurnal raptors reported from the Indian subcontinent, 51 were recorded from Corbett National Park (CNP) in Uttar Pradesh, India, over a 6 year period. The status of these raptors and the conservation problems which could be faced by some of the resident species are discussed. With the exception of the lesser fish eagle *Ichthyophaga humilis*, none of the resident species appear threatened, but continued alteration of the habitat through deforestation and habitat degradation outside the Park is likely to have an adverse effect on the future status and distribution of many species. The Park's overall high avian (and raptor) diversity arises from its immediate proximity to the Himalayan foothills, and represents a wide array of Himalayan avifauna, partly as a result of altitudinal movement. Many raptor species in CNP are either resident or local summer migrants to the Himalayan foothills up to at least 2000 m. A number of high altitude raptors are winter visitors or vagrants to the Park. As the Park and adjacent foothills form one ecosystem, facilitating movement of species from the middle Himalayan foothills to the *Bhabar* tract and vice versa, the status of the species listed for the Park is also applicable to the foothills.

INTRODUCTION

It is surprising that in an area as rich as Corbett National Park in biotic diversity supporting probably the richest variety of bird species in India, no major ornithological studies have been conducted. No extensive literature (except on flora, Pant 1976, Pant *et al.* 1981) exists, though it has long been a favourite locale with birdwatchers. For a long time, the emphasis has been on tiger protection and conservation, and only during the last few years has the great diversity of birds in the area been appreciated. The forest department, whose activity revolves mainly around managing the tiger, is now aware of CNP's unique ornithological heritage, and the great range of birds of prey that it supports. Regular birdwatching and identification camps organised by the forest department are now a yearly feature, and the guides and staff have become more aware of the importance of raptors.

A three month survey for raptors in protected areas covering most of the ten principal biogeographical zones (except the northeast) identified by Rodgers and Panwar (1988) was conducted by William Clark, Dr. Vibhu Prakash and I from January to March 1990. The high numbers of many lesser known resident and migratory raptors observed in CNP influenced our choice of the Park for breeding studies on the rarer resident species.

STUDY AREA

Location and Habitat

Corbett National Park, comprising an area of 920 sq. km extends across two sub-Himalayan districts of Pauri in Garhwal and Nainital in Kumaon, Uttar Pradesh, (Map 1) (29°31' to 29°35'N lat. 78°46' E long.). It is situated in the

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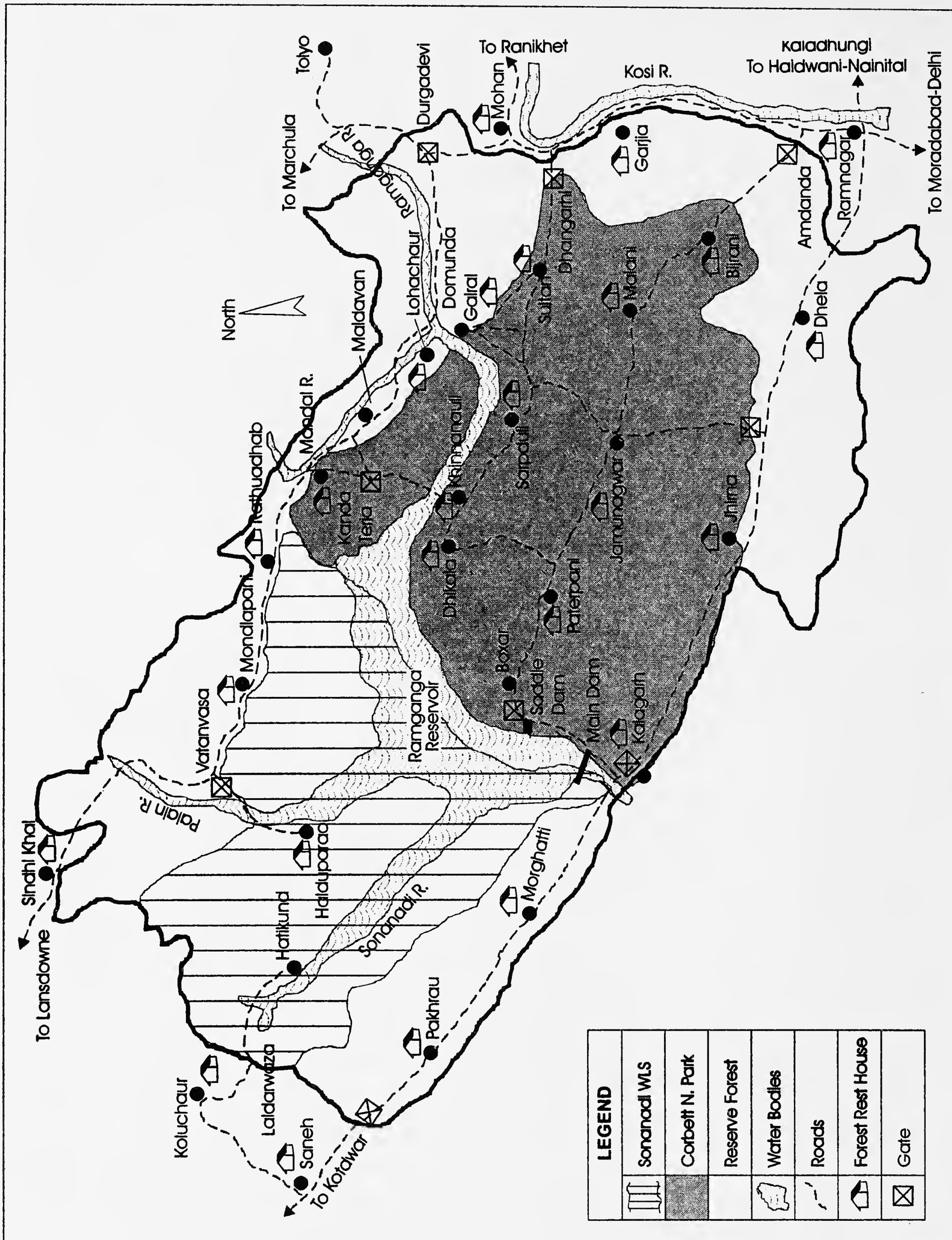

Fig. 1: Map of the Corbett National Park

lower Central Himalayan foothills immediately north of the terai, known as the Sivaliks, which form part of the *Bhabar* tract. The topography is undulating and varied with temporary marshy depressions, ravines and plateaus, (also referred to as Patli Dun), varying in altitude from 250 to 1040 m above msl. A series of more or less parallel ridges run northwest to southeast, decreasing in height southwards towards the plains. The middle reaches of the Ramganga river (the only perennial source of water) flow westward through most of the Park along an elevated plateau (Patli Dun) until the river turns southwards at an abandoned village named Boxar (see map). The central portion of the Park is located partly along the Patli Dun, between the lesser Himalaya to the north and the Sivalik ranges to the south. About 10% of the Park area (mainly prime grassland habitat) has been submerged by the damming of the Ramganga river at Kalagarh, forming a large reservoir 80 sq. km in the western corner of the Park, of which 42 sq. km is within the Park. A number of *sots* (springs) emerge from the numerous ridges which comprise the secondary source of water in the Park.

Climate and Vegetation

There are three distinct seasons: winter (November to February), with often frosty nights and periodic rains, is coldest in January when temperatures can drop to as low as 2.5°C, maximum average during the day is 25°C. Summers (March to June) are warm and sultry, with temperatures as high as 44°C during May/June, and relative humidity around 57%. Thunder showers and hailstorms are not unusual during this period. The monsoon extends from July to September, with an average annual rainfall about 1650 mm. It is warm, with humidity at about 80 to 90%.

Three main vegetation zones exist. Forest, grassland (locally called *chaur*) and riparian forests. The main forest types are a mixture of deciduous, tropical and subtropical. Sal *Shorea robusta* dominates the moist deciduous biotope in the northern region of the Park, forming almost pure forest stands. In the southern half of the Park, the biotope is dry deciduous, especially along the Sivalik hills which, though low, are extremely rugged and steep, and furrowed in every direction by monsoon erosion and seasonal streams. These three zones, together with the varied topography, account for the biotic richness of the area. The *chaurs* occupy a significant ecological status in the Park. They were originally man-made clearings for cultivation and settlements long since abandoned, and support a rich dense growth of medium to tall grasses. There are seven major grasslands: Dhikala, Fulay, Khinnanauli, Paterpani, Mohanpani, Bhadhai and Bijrani, and many smaller ones. Of these, the largest are Dhikala, Fulay and Khinnanauli.

In all, more than 110 species of trees (57 common) 88 of shrubs, 39 of climbers, 42 of grasses and 15 of sedges have been listed for the Park (Pant 1976, Pant *et al.* 1981). The river valley, high banks, and islands are dominated by sheeshum *Dalbergia sissoo*. *Lantana camara* (a south American exotic) is spreading unchecked in many areas and suppressing the regeneration of sal and other herbaceous species. *Cannabis sativa* (bhang) grows profusely in parts of the grassland and in open areas. Bamboo clumps occur frequently on the higher hill slopes. Chir *Pinus roxburghii* is confined in small numbers on some of the highest ridges (around the Sultan watch tower) and in compartment No. 9/10 at Ghilmodya *sot*. For details on flora see Pant (1976), Pant *et al.* (1981).

Avifauna

The diverse habitat types, contiguity with reserved forest to the west and the east (facilitating lateral avifaunal movement and dispersal for breeding species), and its location at the base of the lower Himalaya account for

the high species richness and diversity of CNP. The region is a meeting ground for high altitude and plains species. Over 500 species of birds which include long distance and altitudinal migrants have been reported by certain ornithologists. The area richest in raptor diversity is along the Ramganga river from Gairal to Khinnanauli, Dhikala and Fulay *chaurs* and Gethia Rao, where riverine, grassland and forest habitat together create the heterogeneity preferred by many species (see Map 1). The river and lake attract a variety of water birds, a valuable food source for migratory raptors.

METHODS

From 1990-93, breeding studies mainly on the mountain hawk-eagle *Spizaetus nipalensis*, collared falconet *Microhierax caerulescens* and the lesser fish-eagle *Ichthyophaga humilis* (Samant *et al.* 1995) and Naoroji (1997a, b) were carried out under a joint Bombay Natural History Society and US Fish and Wildlife Service project on Birds of Prey from February 1 to June 15 after which the Park closes for the monsoon. Occasional visits were made during the winter months. These observations form part of breeding studies of lesser known species. During 1993-96 independent studies were conducted by me each year from April to June. Fulay and Dhikala *chaurs*, Gethia Rao, and Gairal to Dhikala were covered by jeep. Kanda (the highest look-out point on the northern boundary of the Park) was regularly surveyed for breeding raptors, and was approached by jeep and the ridge traversed on foot. Hilly, inaccessible regions such as the Sultan watch tower were covered on foot. From Dhangarhi to Marchula, Tolyo and Ranikhet, regular surveys were made by jeep. The checklist, with notes on resident and seasonal species, habitats and general behaviour was prepared during extensive searches for nests throughout the Park, through what could be called sustained opportunistic observations. Reserved forest to the east of the Park was regularly surveyed for breeding raptors as well as the high hills contiguous with the north and northeast boundary of the Park by jeep and on foot. Intensive surveys were conducted in Fulay and Dhikala *chaurs* and Gethia Rao, the area was extensively covered by vehicle and spot counts were conducted in these areas for periods upto five hours. High, elevated points commanding a wide view of the Park were used for spot count surveys (usually during peak raptor activity periods e.g. displays and soaring from 0930 to 1330 hrs), which helped determine the presence of species in the area, and also facilitated nest searches.

RESULTS

A total of 51 species of diurnal raptors were recorded in the Park, representing over 70% of the total number of species recorded for the Indian subcontinent. Whenever observed, breeding dates only for CNP are given. The status of each of these species in the Park (250-1100 m above msl) and the hills (1200-2000 m above msl) is given below:

STATUS OF DIURNAL RAPTORS IN THE PARK

Legend

@	-	Not recorded by me but by reliable observers. Species recorded in similar habitat in Nepal (Inskipp 1989).
#	-	Foraging up to 2500 m.
*	-	Breeding in oak forest at 2400 m.
C	-	Common (regularly seen).
FC	-	Fairly common (less than above).
SB	-	Straggling Breeder.
?	-	Status or abundance uncertain.
R	-	Resident
M	-	Migrant
V	-	Vagrant
B	-	Breeding
LM	-	Local Migrant
PM	-	Passage Migrant
—	-	Not Present
UnC	-	Uncommon (rarely seen)

Osprey *Pandion haliaetus*: Migrant, commonly observed along the Ramganga river and in the vicinity of the dam from October to April. Earliest arrivals sighted by end September. A few individuals observed each year staying on at least till the Park closes in mid June. When or whether they leave the Park is not known.

Status: Park - M; Hills - PM.

Black Baza *Aviceda leuphotes* @: Possible vagrant. Not seen during the study but one sighting reported by a reliable observer (Harak Singh, *pers. comm.* Dy. Ranger, Dhikala).

Status: Park - V; Hills - —.

Oriental Honey-buzzard *Pernis ptilorhynchus*: Resident. Commonly seen throughout the Park. Displays observed through March and April, pairs incubating mostly in May. Appears to be a summer visitor to the hills up to 2000 m where breeding appears unlikely as the area is now mostly denuded, except where the southern slopes of forested foothills and reserved forest in the *Bhabar* tract are contiguous.

Status: Park - C,R,B; Hills - LM,R?.

Black-shouldered Kite *Elanus caeruleus*: Fairly common in the grassland. Numbers fluctuate annually, possibly in relation to prey availability and accessibility. A few pairs may breed, but most exploit the grassland for foraging and appear to breed outside the Park. No nest was located.

Status: Park - R?,LM,FC; Hills - LM,UnC.

Black Kite *Milvus migrans*: Uncommon, found mainly around tourist centres such as Dhikala and Bijrani. One pair nest annually at Dhikala, commencing breeding in March.

Status: Park - UnC,B; Hills - R.

Black-eared Kite *M.m. lineatus*: Migratory and uncommon.

Status: Park - M,UnC; Hills - UnC.

Brahminy Kite *Haliastur indus*. Uncommon, restricted mainly to the dam area. One pair observed nesting at Dhikala during February/March 1992.

Status: Park - UnC,B; Hills - —.

Pallas's Fish-eagle *Haliaeetus leucoryphus*: Visits the Park from mid-September to May to breed. Common along the Ramganga river where pairs take up residence along stretches of the river, repairing and re-using their traditional nests each year. Often observed pirating fish from large cormorants *Phalacrocorax carbo*, osprey and lesser fish-eagle *Ichthyophaga humilis*. The immediate nesting area is actively defended. Foraging and nesting territories probably vary with the food supply. A pair nesting outside the Park along the Kosi river between Mohan and Kumeria at around 300 m (where food was apparently scarce) foraged over longer distances than pairs within the Park. The adults were occasionally observed flying over Bhounkhal village (1400 m) atop a ridge whose eastern face rose directly above the Kosi to the Ramganga river (below the western face), a few kilometres upstream of Marchula. Within the Park pairs foraged along 4 to 7 km stretches of river, intruding into the peripheral territories of other pairs. Most birds leave by May, the odd adult or subadult observed staying on at least till the Park closes in June.

Status: Park - M,B,C; Hills - PM.

White-tailed Eagle *Haliaeetus albicilla*: Occasional, individuals (adults and mainly juveniles) visit the Park for a few days in winter. Usually seen along the Ramganga, mostly in Dhikala and Fulay *chaurs* feeding on carrion or pirating food from the Pallas's fish-eagle, *Aquila* and other smaller raptors. Also reported from Loha Chaur along the Mandal river on the northern boundary of the Park (Shahid Ali, *pers. comm.*).

Status: Park - M,O; Hills - —.

Lesser Fish-eagle *Ichthyophaga humilis*: One of the most endangered raptors in India and the species most at risk in Corbett. It is restricted to the Ramganga riverine habitats where it is fairly common. It feeds exclusively on fish and favours forested habitat adjacent to fast flowing streams and rivers at altitudes from 300 to 2400 m

(Ali and Ripley 1987, Baker 1932). Recent surveys by me in the Kumaon hills have indicated that viable habitat above 1000 m has shrunk in the middle Himalaya, and that the species now mainly ranges between 300 m and 1300 m. Much of its former habitat in the middle Himalayan ranges has been denuded and additionally contaminated by pesticides.

The direct effects of deforestation and changing land use patterns which have polluted the Himalayan riverine ecosystem threaten the species' survival. Besides Kumaon and Garhwal, Nepal's river systems have similarly been affected (Ormerod, 1990), and the species may be under similar threat in other parts of its range. Thinner than normal egg shell fragments collected from one nest analysed by Dr. Robert Risebrough of USA contained significant levels of DDT and dieldrin (Naoroji 1997b). In 1993, no nest was located. Courtship commences by February, incubation by mid March. Nests were closely spaced, often not more than 2 km apart. This specialised feeder is shy and easily disturbed at the nest, and successful breeding is further limited by nest predation by the common langur *Presbytis entellus*, yellow-throated marten *Martes flavigula* and food pirating by the Pallas's fish-eagle. Incubation was unsuccessful in seven nests located at Corbett. Two pairs hatched young, which did not survive for more than four to five days. One nest was located at Garjia on the Park's eastern boundary but incubation was unsuccessful. Observed occasionally along the Mandal river at the northern boundary of the Park and along the upper reaches of the Ramganga in the north-eastern buffer zone of the Park from Domunda to Marchula. Its breeding behaviour will be described in a separate paper under preparation. The species is now rare outside the Park with only two sightings in six years along the highly disturbed Kosi river.

Status: Park - FC,R,B; Hills - R,B,UnC.

Bearded Vulture *Gypaetus barbatus*. A rare vagrant to the Park in winter. A single individual observed flying over Dhikala across to Kanda (Harak Singh, *pers. comm.*). Relatively common from 1500 m above msl and above, even more abundant at higher altitudes. The massive denudation of the middle ranges has enabled this open habitat species to expand its foraging range to lower altitudes (around 1000 m) wherever suitable hill habitat is available. Outside the Park, individuals (adults and immatures) sporadically observed by the author during winter and also April/May flying over degraded reserved forest at Bhalon (600 m), east of the Kosi river adjacent to high ranges. One immature observed from the Claridges resort along the Kosi river (Shahid Ali, *pers. comm.*). As long as food and safe nesting sites are available, the species will continue to prosper.

Status: Park - V; Hills - FC,R,B.

Egyptian Vulture *Neophron percnopterus*: A fairly common resident in the Park. Nests both on trees and on high eroded mud banks of the Ramganga and Kosi rivers. Nests are traditionally used each year if undisturbed. Nesting period stretches from end February/March to early or mid June. Newly hatched downy nestlings have been observed from early to mid May. Breeds in the hills up to at least 2000 m.

Status: Park - FC,R,B; Hills - R,B.

Indian White-backed Vulture *Gyps bengalensis*: Commonest vulture in the Park, breeding in winter. Also summers (no evidence of breeding) in the middle foothills up to about 2000 m. Breeds from November to March.

Status: Park - C,R,B; Hills - R,LM,C.

Long-billed Vulture *Gyps indicus*: The race *G.i nudiceps* (resident in the foothills) is observed mainly in the northern sector of the Park, pairs breeding singly and solely on trees. Young fledge by early May but are nest dependent till early June.

Status: Park - R; Hills - R.

Himalayan Griffon *Gyps himalayensis*: Commonly seen local winter migrant to the Park from the surrounding hills where it breeds in summer. No nests observed in the hills

immediately to the north up to 1800 m.

Status: Park - LM,C; Hills - C,R,B.

Eurasian Griffon *Gyps fulvus*: Uncommon, seldom seen. Occurs singly in the Park and in adjoining reserved forest, mainly during the winter months. No evidence of breeding in the Park or adjoining foothills.

Status: Park - M,R?,UnC; Hills - —.

Cinereous Vulture *Aegypius monachus*: Migrant, mostly seen singly or in small groups of 3 to 4 on carcasses in the relatively open areas of the Park during the winter months from November to early March. Frequently observed in the *chaurs* around Dhikala (N and S of the Ramganga river) and along the northern boundary of the Park at Marchula, Chimtakhal to Tolyo and along the Kumeria - Ranikhet road.

Status: Park - M; Hills - M,UnC.

Red-headed Vulture *Sarcogyps calvus* #: Common throughout the Park and observed foraging up to 2500 m. It is equally at home in moist-deciduous forest or in the mix of degraded open country, pine and oak in the middle ranges.

Status: Park - C,R,B; Hills - R,B,FC.

Short-toed Snake-eagle *Circaetus gallicus*: A vagrant, opportunistic visitor to the Park for foraging. It was sighted only twice in six years during winter. The individuals foraged in the *chaur* for a few days and then left the Park. The species is fairly common in the agricultural areas beyond the Park's southern boundary where the habitat is more suitable. Occasionally seen quartering barren hill slopes up to 2000 m, where it is a local migrant.

Status: Park - V; Hills - LM.

Crested Serpent-eagle *Spilornis cheela* #: One of the commonest raptors in the Park — an opportunist and adaptable species (Naoroji, 1994b). Found throughout the lower and middle Himalaya up to 2600 m and probably higher in its northeastern range. Though the species usually builds its own nest, three pairs were observed over three consecutive seasons breeding in unused nests of the Indian white-backed vulture, changeable and mountain hawk-eagles. In Corbett, the prey varied from the usual snakes, lizards and rodents (Naoroji and Monga 1983, Naoroji 1985), occasionally to birds e.g. jungle babbler *Turdoides striatus*, common myna *Acridotheres tristis*, and once a flying squirrel *Hylopetes fimbriatus* (Naoroji, 1994b). A pair were observed fishing for fingerlings in shallow, tarsus-deep water. Inspite of its commonness, none of the eggs in the three nests located hatched successfully. The species is easily driven off the nest by the common langur which, along with the yellow-throated marten, feed on the eggs. Courtship displays were observed from February to early March, incubation by end March through April or variably later in the Park. Unsuccessful nesting may be due to the high rate of nest predation, and possibly the cumulative effect of pesticides ingested from the food chain through predation on water snakes. Nesting success was higher outside the Park, in relatively unprotected, degraded reserved forest close to human habitation, and this was probably due to a lower density of natural predators.

Status: Park - C,R,B; Hills - R,B,LM.

Harriers: are migratory (mainly passage migrants), seen sporadically, either individually or in twos and threes, in open *chaurs* during winter.

Western Marsh Harrier *Circus aeruginosus*: A few individuals can be observed quartering the *chaurs* along the banks of the Ramganga river and near the reservoir.

Status: Park - M; Hills - PM.

Eastern Marsh Harrier *Circus spilonotus*: A rare vagrant. The only confirmed sighting of a juvenile quartering the Dhikala *chaur* and Gethia Rao in March is a range extension, as it has not been previously recorded west of Assam (Ali and Ripley, 1987), and a record for the Park (Naoroji, 1994a).

Status: Park - V; Hills - —.

Hen Harrier *Circus cyaneus*: Infrequently observed, does not stay continuously throughout the winter, but stops over in the Park for short periods. More common in the hills.

Status: Park - M,UnC; Hills - M,FC.

Pallid Harrier ***Circus macrourus***: Infrequent winter migrant. Stops over in the Park for short periods, probably on passage.

Status: Park - M; Hills - PM.

Montagu's Harrier ***Circus pygargus***: Status same as Pallid Harrier.

Status: Park - M; Hills - PM.

Crested Goshawk ***Accipiter trivirgatus*** @: Uncommon, not observed by me, but probably resident and has been reliably reported (Harak Singh, *pers. comm.*).

Status: Park - UnC,R; Hills - —.

Shikra ***Accipiter badius***: The commonest resident *Accipiter*, frequently observed throughout the Park. Breeds in the hills up to 1400 m (Ali and Ripley 1987) but frequently observed during summer at 2000 m.

Status: Park - C,R,B; Hills - R,LM.

Besra ***Accipiter virgatus***: Mainly a local migrant from the higher foothills, where it breeds.

Status: Park - LM; Hills - R,B.

Eurasian Sparrowhawk ***Accipiter nisus***: Migratory in the Park, the resident race probably breeds at higher altitudes above 2000 m.

Status: Park - LM; Hills - R?B?

Northern Goshawk ***Accipiter gentilis***: Migratory. Rare, one adult seen in May at Kanda (1000 m). A record of the species nesting in Garhwal at 1000 m (Baker, 1932), lends credence to the belief that sporadic breeding may occur in the lower foothills.

Status: Park - LM; Hills - LM,B?.

White-eyed Buzzard ***Butastur teesa***: Uncommon, only seen occasionally in the open grassland, which it exploits for foraging. It probably breeds outside the Park. A vagrant to the hills up to 2000 m (in summer) where excessive deforestation has probably extended its foraging range.

Status: Park - UnC; Hills - V.

Common Buzzard ***Buteo buteo***: Both races are migratory and infrequently observed in the Park. The Steppe buzzard *Buteo buteo vulpinus* is commoner; the Eurasian race *Buteo buteo japonicus* is uncommon and usually observed over degraded hill slopes to the north of the Park.

Status: Park - M; Hills - M,PM.

Long-legged Buzzard ***Buteo rufinus***: Migratory and though not common, it is more frequently seen in the Park than the common buzzard.

Status: Park - M; Hills - PM.

Black Eagle ***Ictinaetus malayensis*** #*: Partial to hill forest. Found at low density throughout the Park, mainly north of the Ramganga river. Occasionally seen on the lower slopes of the hills (once observed at Gairal) but more frequently along the higher ridges such as at Kanda. It is also commonly associated with Oak forest up to 2500 m. Its status in the hills varies from area to area, determined mainly by the level of habitat degradation.

Status: Park - UnC,R,B; Hills - FC,R,B.

Lesser Spotted Eagle ***Aquila pomarina***: Status within the Park is rare, with only one recorded sighting. A pair seen outside the Park in September 1991 near Kaladunghi along the margin of forest and cultivation (preferred habitat), were probably breeding. Two unidentified *Aquila* observed soaring and hunting at a distance over barren hill slopes interspersed with Oak (*Quercus*) and Chir *Pinus roxburghii* forest at Chaubattia, Ranikhet (1800 m) in end May 1993 and 1994 appeared, from a photograph, to be this species, according to William S. Clark, (*pers. comm.*). A single bird seen by Shahid Ali (*pers. comm.*) in reserved forest outside the Park near Chopda in March.

Status: Park - LM,?,R?,O; Hills - V.

Greater Spotted Eagle ***Aquila clanga***: Uncommon migrant to the Park. Mainly observed around the Dhikala *chaur* perched on trees in the vicinity of the river and reservoir. A few juveniles, occasionally an adult, observed stopping over sporadically during winter.

Status: Park - UnC,M; Hills - PM.

Eurasian Tawny Eagle ***Aquila vindhiana***: Rare both within and outside the Park. Not

observed by me but two sightings within and outside the Park (Samant *et al.*, 1995) indicate its presence in the area. Two *Aquila*, possibly this species, were seen by me in early June, quartering the barren slopes below Almora at around 1200 m.

Status: Park - O,LM?; Hills - —.

Steppe Eagle *Aquila nipalensis*: Uncommon migrant, though seen more frequently than greater spotted, during stop overs. Mostly juveniles observed, and very occasionally adults. In the hills, hundreds of steppe eagles were observed on passage from end September to early November. Large numbers of steppe eagles were observed stopping over in November-December on onward migration and from mid-March and early April on return migration at municipal garbage dumps at Ranikhet and Nainital.

Status: Park - UnC,M; Hills - C,M,PM.

Imperial Eagle *Aquila heliaca*: Uncommon migrant, less frequently observed than the greater spotted and steppe eagles.

Status: Park - O,M; Hills - PM.

Golden Eagle *Aquila chrysaetos*: A rare winter vagrant to the Park. One individual observed in January by William Clark (*pers. comm.*) the main entrance at Dhangarhi. Two birds, an adult and an immature seen at Domunda on February 15, 1998 (Shahid Ali, *pers. comm.*). Occasionally seen foraging from 1800 m to 3000 m, where the increasing human population and resultant disturbance coupled with the degradation of the middle foothills have decimated its natural prey and safe nesting sites. It is commoner at higher altitudes (3000 m to the snow line) where inaccessible rock ledges provide safe nesting sites above the preferred mix of high-altitude meadows and coniferous forest where it procures its food.

Status: Park - V; Hills - O.

Bonelli's Eagle *Hieraaetus fasciatus*: Fairly common resident in the Park, commoner in the hills north of the Park from 1000 m to 2000 m, where extensive degradation appears to have favoured the species. Three nests observed between Bhounkhal and Tolyo on *chir* pine. Though not observed, the species may also be nesting on suitable rocky ledges. Incubation begins by February, young usually hatch by end March and fledge by mid May.

Status: Park - FC,R; Hills - C,R,B.

Booted Eagle *Hieraaetus pennatus*: A sporadic winter visitor and passage migrant in the Park. Not very common, mostly observed soaring.

Status: Park - M; Hills - PM.

Rufous-bellied Eagle *Hieraaetus kienerii*: A forest dependent species favouring hilly tracts. Fairly common resident throughout the Park, both adults and juveniles seen up to 1000 m mostly observed soaring, rarely perched. Unfortunately, no nest was located. Found at comparatively low densities, and continued shrinking of its forested habitat could pose a threat to the species outside the Park.

Status: Park - FC,R,B; Hills - —.

Changeable Hawk-eagle *Spizaetus cirrhatus*: Common throughout the Park, mainly south of the Ramganga river; more frequently seen than the mountain hawk-eagle. Breeding coincides with that of the mountain hawk-eagle, variably from end February through March, when incubation commences, till the end of May, up to mid June when young fledge. Observed breeding outside the Park in degraded and disturbed forest habitat near human habitation, and also in undisturbed forest areas.

Status: Park - C,R,B; Hills - —.

Mountain Hawk-eagle *Spizaetus nipalensis*: A fairly common resident, mostly heard or seen perched in forest at the edge of a clearing. Rarely observed soaring. More commonly observed in hill forest in the northern section of the Park than in the southern portion. Nesting females of the northern race are extremely aggressive in nest defence, unhesitatingly making contact with intruders climbing trees within a radius of 20 to 30 m of the nest. Conflict usually arises when villagers

lop trees in the vicinity of nests near villages, inviting determined attacks, sometimes resulting in the villagers destroying the nests. There are two known instances outside the Park near Chopda where women lopping branches were attacked without warning, fell and succumbed to their injuries. The species was also observed to be pugnacious and aggressive in nest defence against the numerous natural predators, mainly the yellow-throated marten *Martes flavigula* and the common langur *Presbytis entellus*. Within the Park it takes a greater number of the large Galliformes such as kalij pheasant *Lophura leucomelana* and red junglefowl *Gallus gallus* (which are more easily available), and smaller prey like parakeets, doves, mynas and tree pies. Outside the Park it subsists primarily on small birds, taking a lesser percentage of the scarcer Galliformes. The species' original countrywide distribution (Ali and Ripley 1987, Baker 1932) in the middle Himalayan foothills from 1400 m to 2500 m has shrunk due to massive deforestation and resultant scarcer prey. The available habitat may not be able to sustain a viable population except in certain pockets. In Kumaon, the species is now more commonly seen in the predominantly *sal* dominated *Bhabar* tract from 600 m to 1200 m, and only occasionally in the higher foothills. The only unmistakable sighting I have had in the Kumaon hills was at Munsiari, Pithoragarh dist. With continuing human pressure on the depleted forests of the Sivaliks and Duars — changing land use practices and repeated summer burnings — the mountain hawk-eagle may soon run out of habitat except in suitable protected areas within its former range. Breeds variably from Feb./Mar. to May.

Status: Park - FC,R,B; Hills - UnC,R,B.

Collared Falconet *Microhierax caerulescens*: Observed mostly during winter (October-January), hunting at the edge of natural or man-made clearings in forest. Seen frequently at Dhikala watch tower, High Bank and at Dhangarhi. Outside the Park, observed during winter at Sitabani and once at Chopda village in May. Rarely observed in summer when it nests. Breeding status vague, perhaps a straggling or rare breeder in the Park. Only one nest was located over a three year study period and incubation was unsuccessful (Naoroji, 1997a). The species breeds in disused nest-holes of the large green barbet *Megalaima zeylanica* or the lineated barbet *M. lineata*. Breeding extends from end February to May.

Status: Park - R,SB?,LM?; Hills - —.

Lesser Kestrel *Falco naumanni*: Passage migrant, observed at Kumeria outside the Park (W.S. Clark *pers. comm.*).

Status: Park - PM, Hills - PM.

Common Kestrel *Falco tinnunculus*: Passage migrant, seen around September/ October, foraging in open grassland. The resident race *F.t. interstinctus* is a common breeder in the hills (Ranikhet) from 1500 to 3500 m, breeding recorded by me from March to June.

Status: Park - LM; Hills - C,R,B.

Amur Falcon *Falco amurensis*: Very occasional winter passage migrant. Observed once in April 1976 at Dhikala *chaur* by Shahid Ali (*pers. comm.*). In 1997, a flock of about 150 to 200 observed in Dhikala *chaur* (Rajiv Bhartari, *pers. comm.*).

Status: Park - O,PM; Hills - —

Eurasian Hobby *Falco subbuteo*: Migrant, mainly observed in the Park during winter in the Dhikala *chaur* but doubtless frequents similar open spaces within the Park. Over two seasons three adults were observed in April, May and June, perched on small boulders about 20 cm high in open grassland. From these look-out perches, they would hawk insects and hunt warblers and larks. Breeds in the hills north of the Park. A breeding pair located at Ranikhet at 1800 m in June.

Status: Park - LM; Hills - R,B.

Oriental Hobby *Falco severus*: On April 4, 1995, a pair was seen hawking insects in the late evening at Gethia Rao. Only one sighting in six years.

Status: Park - O,PM; Hills - —.

Peregrine Falcon *Falco peregrinus*: Migrant, a few individuals occasionally seen during winter, perched on dead trees and stumps in open areas within the Park in the vicinity of the Ramganga river, Dhikala *chaur* and the reservoir.

Status: Park - M,UnC; Hills - PM.

The resident **Shaheen *F.p. peregrinator*** is a forest dependent falcon, seen throughout the Park especially from high vantage points. Breeds on cliffs on the upper slopes of steep forested hills and up to at least 2000 m in the Himalaya (Ali and Ripley, 1987). Outside the Park seen between Chimtakhal and Kartkinow and frequently between Kumeria and Panua Deokhun on the main Dhangarhi - Ranikhet road.

Status: Park - FC,R,B; Hills - R,B.

Summary

Except for the lesser fish-eagle (status threatened in Garhwal/Kumaon) whose limited range in the lower Himalaya has shrunk and is still under pressure from pesticides, human encroachment and disturbance along its riverine habitat, the status of the raptors at Corbett appears to be secure at present.

Due to its geographical location, Corbett Park harbours a high diversity of resident, long distance and altitudinal migrant raptor species. There is a high rate of natural predation affecting some of the less aggressive species, but most raptors remain vulnerable mainly to loss of forest cover and chemical contamination of the riverine ecosystem and agricultural areas outside the Park. Each of the species listed is susceptible to these changes, some more than others. Constant population monitoring is essential, and if numbers are on the decrease, the cause and effect on that particular species could be ascertained before the trend becomes irrevocable.

The most successful nesters were found to be the hawk-eagles, which had the largest territories and were more successful in fledging young than other large raptors within and outside the Park. However, habitat loss and fragmentation, coupled with human persecution throughout the *Bhabar* tract could seriously affect their future status. Open habitat species such as the various vultures, Bonelli's Eagle, Common Kestrel and the harriers have benefitted from the severe denudation of the lower foothills, with adverse consequences to the forest dependent species.

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SMALL CARNIVORES IN TWO PROTECTED AREAS OF ARUNACHAL PRADESH[1]

Aparajita Datta[2]

(*With one text-figure*)

Key words: small carnivores, Arunachal Pradesh, Pakhui Wildlife Sanctuary, Namdapha Tiger Reserve

A survey of the small carnivores in Arunachal Pradesh was conducted in the Pakhui Wildlife Sanctuary and the Namdapha Tiger Reserve from November 1995 onwards. All direct sightings in the wild, captive individuals, dead specimens and reports by local tribals during the study period have been documented in this paper. A total of fifteen different species belonging to the Families Viverridae, Mustelidae and Herpestidae were recorded during this survey.

Introduction

As in most taxonomic groups, Arunachal Pradesh (A.P.) is home to a high diversity of small carnivores. In a recent review of small carnivores in A.P., Choudhury (1997) outlines the known and probable distribution of all species within protected areas there. He has given a detailed account of species occurrence in either individual protected areas or districts in A.P.

I sighted several small carnivores in Pakhui Wildlife Sanctuary (WLS) during a study on squirrels and primates from November 1995 to April 1996 and a four year study on hornbills which commenced from February 1997. I also made two visits to Namdapha Tiger Reserve (TR), which forms a second study site for the hornbill study. The note is a documentation of all direct sightings in the wild, captive individuals, dead specimens and reports by local tribals during this period. As Choudhury (1997) points out, no study on small carnivores has been undertaken in this region and information on their conservation status, abundance and distribution is scanty. Some anecdotal information on the diet and habits of the few species sighted is also presented here.

Study sites

Pakhui WLS (92° 7.5'-92° 22' E and 26° 53.7'-27° 16.2' N) is located in East Kameng dist. in western Arunachal Pradesh (Fig. 1). The sanctuary covers an area of 862 sq. km and is bounded to the north and west by the River Bhareli, to the east by the Pakke river and to the south by the Nameri WLS and reserve forests of Assam.

Pakhui is mainly a tropical semi-evergreen forest (Champion and Seth 1968) with altitude ranging from 200 m to 1500 m above msl. It lies in the foothills of the Himalaya and the terrain is steep and inaccessible in the higher reaches to the north. More than 230 plant species (angiosperms) have been recorded from here with a high representation of species from the Euphorbiaceae and Lauraceae families (Datta and Goyal, *in press*). The sanctuary is drained by a number of small rivers and perennial streams of the Bhareli and Pakke rivers, both of which are tributaries of the Brahmaputra. Cane extraction on a commercial basis occurred here till 1991. Occasionally, cane-cutters enter the forests here from the adjacent reserve forests of Assam. A small part of the forest near the southern boundary had also undergone some felling in the past before the area was declared a sanctuary in 1978.

A vast portion in the central and northern part of the sanctuary is quite inaccessible due to the dense vegetation, hilly terrain and the lack of trails. The only village, Mabusa, to the south

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FN: However, Choudhury JBNHS, 94(1) (1997) has reported the red panda from higher areas of Balpakram (1023 m) and Nokrek (1412 m) National Parks in Garo Hills, the lowest elevation recorded.

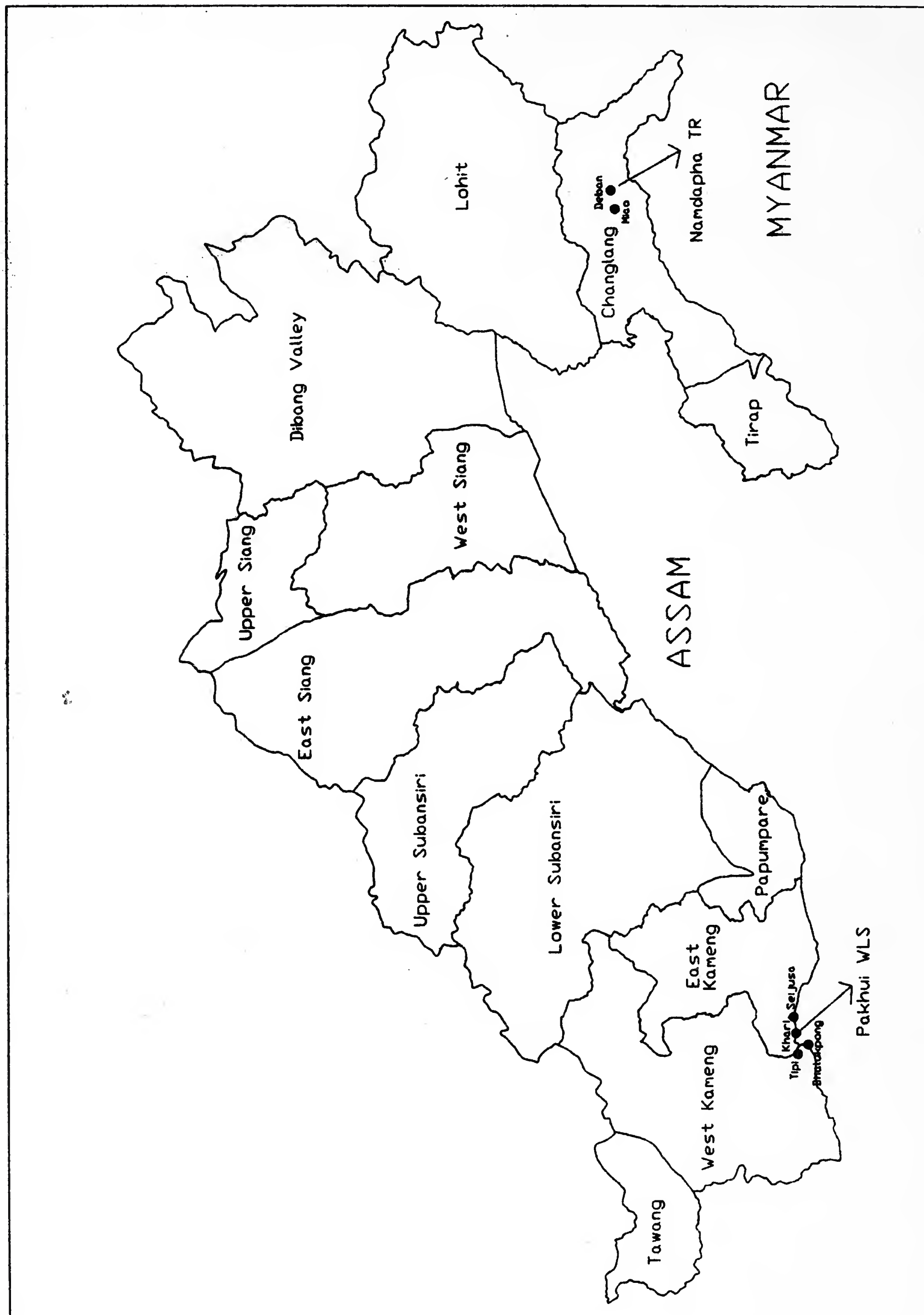

Fig. 1: Map showing locations of study sites in Arunachal Pradesh

of the sanctuary has been relocated outside. One or two settlements are present near the northern boundary. The Bhareli river is a barrier to human disturbance. Therefore, most of Pakhui WLS, except for a small strip to the south, has undisturbed primary forest.

Another study site is in Namdapha TR (27° 23'-27° 39' N and 96° 15'-96° 58' E) in Changlang dist., eastern A.P. The Namdapha TR covers an area of 1,985 sq. km, with a core area of 1,808 sq. km of primary evergreen forest which forms the national park (Fig. 1). The altitudinal range, from 200 m to above 4500 m, has resulted in the presence of diverse and rich fauna within this area. Many small streams and rivers drain into the Noa-dihing, a tributary of the Brahmaputra which flows through the reserve. There are three major forest types, viz. the northern Tropical Evergreen forests, north Indian Tropical Moist Deciduous forests and Miscellaneous forests (Champion and Seth 1968). It is bordered on the north by the Kamlang Wildlife Sanctuary, to the west of the Noa-dihing river lie the reserve forests of Lohit dist. To the south and southeast lie high mountain ranges and the international border with Myanmar. It is contiguous with reserve forests and sanctuaries to the south and west, which act as buffer zones, though the reserve forests and unclassed state forests across the Noa-dihing in Lohit dist. are severely degraded. There are settlements of Mishmi, Khamti and Tangsa tribes as well as cultivated land. Chakma settlements and their farmlands occur just adjacent to the border of the National Park on the banks of the Noa-dihing river as one approaches Deban from Miao by the Miao-Vijoynagar road. This road runs right through the sanctuary, though it is motorable only upto Deban and 17th mile camp.

Viverridae

Of the nine civet species known to occur in India, seven occur in Arunachal. Two of these are restricted to the northeast in India. The binturong and spotted linsang are listed in Schedule I of the Wildlife (Protection) Act, 1972, while other civet species are listed in Schedule II. Choudhury (1997) reports the occurrence of the small-toothed palm civet (*Arctogalidia trivirgata*) in eastern A.P., a species not reported earlier within Indian limits.

1. Common palm civet (*Paradoxurus hermaphroditus*)

I sighted the palm civet on four occasions. All the sightings were on trees. On one occasion, the animal was resting among the branches and a mass of basket ferns and lianas about 15 m up a tree during the day in Tipi (Pakhui WLS). The other three sightings were around 7-8 pm in Seijusa and Khari (Pakhui WLS). Two sightings were on a fruiting tree of *Gynoecardia odorata* (Chalmugra in Assamese), a cauliflorous species. Civet droppings with seeds of *G. odorata* are very commonly seen along forest trails in Pakhui WLS.

2. Himalayan palm civet or Masked palm civet (*Paguma larvata*)

The Himalayan palm civet was not sighted at all, nor did I come across any indirect evidence of the species, but it is reportedly common and occurs all over A.P. (Choudhury 1997).

3. Spotted linsang or tiger-civet (*Prionodon pardicolor*)

Even though the tiger-civet was not sighted, a local assistant when shown the plates in Prater (1980) insisted that he had seen the animal in a plantation in the adjacent Papum Reserve Forest, East Kameng dist., near a fig tree. This species is considered the rarest of the small carnivores (Choudhury 1997).

4. Large Indian civet (*Viverra zibetha*)

This was never sighted in the sanctuary, though a skin of the animal was seen at Bhalukpong (Assam-Arunachal border town, West Kameng dist.). It had been used for covering the *dao* of a Nishi tribal.

5. Small Indian civet (*Viverricula indica*)

The small Indian civet reportedly raids houses to kill poultry (Prater 1980, Choudhury 1997). In Pakhui WLS, tribals employed by the Forest Department had kept some chickens in a bamboo enclosure in Khari area. One evening in May 1997, there was a big commotion and we found a small Indian civet inside the enclosure. It had killed two hens and some of the chicks had been bitten, while others had died, probably of shock. On our opening the enclosure, the animal ran off and did not return. The second sighting I had of the species was on the Miao-Vijoynagar road on the way to Deban in Namdapha TR at around 7 pm on November 20, 1997.

6. Binturong or bear-cat (*Arctictis binturong*)

I have had two confirmed sightings of this species, two other glimpses of a black animal could not be confirmed. Both sightings were in Tipi, and both on a fruiting fig (*Ficus macclellandi*). On the first occasion in 1996, on hearing us, the binturong moved into a tangle of lianas and was only partly visible. In December 1997, we observed it for about 15 minutes, moving slowly on the tree and periodically feeding on the ripe figs. It did not shy away, though there were eight of us watching from about 20 m away. I photographed it, however, the pictures are not clear. Nitin D. Rai (a colleague) also sighted it sleeping curled up on a tree in June 1995 near Seijusa. My local assistants have also seen it during the daytime on a fruiting tree of *Ficus lamponga* (Dimoru), a free-standing cauliflorous fig. The binturong may be more diurnal than previously supposed. A skin of the animal was also seen with a Nishi tribal in Seijusa village. The species has been photographed using camera traps in Namdapha TR by Vidya R. Athreya (Athreya and Johnsingh 1995).

Indirect evidence

Though civet sightings were not frequent, droppings on fallen logs, rocks and stones were very common. Besides figs, the food species of civets include fruits of *Vitex pentaphylla, Elaeocarpus ganitrus* (Rudraksh), *Gynoecardia odorata,* and the palm *Livistonia jenkinsii* (Tokko pat). From December 1997 to January 1998, most civet droppings contained seeds of *Vitex pentaphylla.* Seeds of some climbers were also found in the droppings. *Gynoecardia odorata* seeds collected from civet droppings were viable and germinated successfully (87% germination success). Civets are hence probably important dispersers of some of their food plants in this area.

MUSTELIDAE

Among mustelids, only the hog-badger and the clawless otter are listed under Schedule I of the Wildlife (Protection) Act, 1972. Ferret badgers, martens and the two other otter species are listed under Schedule II.

1. Weasels (*Mustela* spp.)

Of the three weasel species reported to occur in Arunachal Pradesh, both the stripedbacked weasel (*Mustela strigidorsa*) and the yellow-bellied weasel (*Mustela kathiah*) may occur in the higher inaccessible areas of Pakhui WLS since their known altitudinal distribution ranges from 1000 to 2000 m above msl. The tail of an animal trapped by tribals in Seijusa might have been that of a weasel. A specimen of the stripedbacked weasel from Namdapha TR was seen in the Miao Museum collection maintained by the A.P. Forest Department.

2. Yellowthroated marten (*Martes flavigula*)

Martens were sighted on three occasions in Pakhui WLS, all during daytime. A pair was sighted running down a huge fruiting strangler fig in Tipi (undisturbed primary forest). The second sighting was that of a solitary animal on a trail less than 100 m from the Forest Department camp and habitation at Seijusa. The animal was sighted at dusk and was moving under a nest tree of the wreathed hornbill. On

becoming aware of my presence on a machan near the tree, the marten scampered off into the undergrowth. Yellowthroated martens are reported predators of hornbill chicks at nests (Poonswad *et al.* 1987). A third sighting was of a solitary animal on a forest trail. The other individual of the pair was nearby. It was coming from the direction of a large fruiting strangler fig tree. This area was also in secondary forest frequented by people in Seijusa. It made some peculiar calls on sighting me. I sighted a pair of martens in Namdapha TR on the stretch of road between Hornbill camp and Haldibari in November 1997. The pair were calling continuously from the ground, but they clambered up a tree trunk on being disturbed. Two animals, probably martens, also entered into the wooden camp at Hornbill (Namdapha TR) in the middle of the night, probably in search of food near the smouldering fire where food had been cooked. Though I did not get to see them properly, from the calls they made, it was likely that they were martens. I also saw a solitary yellowthroated marten foraging on a large fruiting *Ficus* tree near Deban, in the late afternoon on a cloudy, rainy day in April 1996.

3. Ferret-badgers (*Melogale* spp.)

A stuffed specimen of a ferret-badger was recovered from a local tribal in Seijusa (Pakhui WLS). The specimen had a pungent musky odour. Apparently, these creatures are commonly seen only along small streams or rivers at dusk. Since two species reportedly occur in A.P., I got the specimen identified at the Zoological Survey of India, Calcutta. The main difference between the two species is in the molar teeth. In the Burmese ferret-badger (*Melogale personata*), the molars are massive and wide-crowned, while in the Chinese ferret-badgers (*M. moschata*), they are small and narrow-crowned (Prater 1980). The Burmese ferret-badger also has a narrow white stripe running from the crown of the head to the middle of the rump, which in the Chinese ferret-badger usually extends only till the shoulders. The specimen I had obtained was identified as the Burmese ferret-badger.

4. Hog-badger (*Arctonyx collaris*)

There was no evidence or sighting of the hog-badger in Pakhui WLS. In Namdapha TR, one was reportedly sighted by Mr. P.K. Biswas, a Forest Department employee.

5. Otters (*Lutra* spp.)

All three otter species from India occur within A.P. Though otters were never sighted, otter tracks and fresh spraints were very commonly seen along the Bhareli river in Tipi, the smaller perennial streams of Khari and Lalung nala, towards Upper Dikrai nala beyond Khari, and also along Juli and Diju nala near Seijusa. Pakhui is criss-crossed by innumerable perennial streams, besides being bounded by two large rivers, therefore there is extensive otter habitat here. An otter skin was seen in 1996 with a local who was going to sell it in a local market.

6. Red panda or cat-bear (*Ailurus fulgens*)

Even though Choudhury (1997) mentions that the presence of red panda in Pakhui remains to be confirmed, I feel it is unlikely that the species would occur within Pakhui WLS. The elevation is above 1500 m in some places, but the general elevation is rarely above 1000 m and the vegetation is mainly tropical semi-evergreen forest. The red panda is found in subtropical and moist temperate forest with bamboos, and in subalpine forest. These vegetation types do not seem to occur within the sanctuary, even though the northern higher areas of the sanctuary still remain unexplored. I have seen tracks of the red panda in the snow in Eagle's Nest Sanctuary (which adjoins Pakhui WLS to its west) where a certain thin bamboo (reportedly its food species) predominates, but such vegetation is absent from Pakhui WLS. Corbet and Hill (1992) report an altitudinal range of 2200 to 4800 m for the species. In Eagle's Nest Sanctuary, red panda habitat occurs from 2400 to 2800 m (especially

the area between Lama camp and Sunderview camp). This area is snow-bound in winter. No part of Pakhui is snow-bound in winter.

Herpestidae

All species of herpestids are listed in Schedule IV of the Wildlife (Protection) Act of 1972.

1. Small Indian Mongoose (*Herpestes auropunctatus*)

The small Indian mongoose was sighted in open areas around habitation several times. One was kept as a pet by my assistant for some time till it was killed by a dog.

2. Common mongoose (*Herpestes edwardsi*)

The common mongoose was not sighted at all.

3. Crab-eating mongoose (*Herpestes urva*)

The crab-eating mongoose was reported in Namdapha TR by Athreya and Johnsingh (1995).

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THE BIRDS OF GOA[1] (Part II)

Heinz Lainer[2]

(continued from JBNHS 96(2))

167. (546) **Alexandrine Parakeet**
***Psittacula eupatria* (Linn.)**

Uncommon resident (?) in very small numbers. Singles and groups of up to 5 birds occasionally seen at coastal villages of North Goa. Possibly, escaped cage-birds.

168. (550) **Rose-ringed Parakeet**
***P. krameri* (Scopoli)**

A common breeding resident in large numbers, from seaside coconut groves to the base of the Ghats.

169. (558) **Blossom-headed Parakeet**
***P. cyanocephala* (Linn.)**

A common resident, in large numbers, of the coastal belt, wooded valleys in the midland region and of the base and lower slopes of the Western Ghats. Breeding was noted in February and December.

170. (564) **Blue-winged Parakeet**
***P. columboides* (Vigors)**

Fairly common resident, in moderate to considerable numbers, of the lower slopes of the Sahyadris and some of their outlying hillocks. Only small numbers remain during the monsoon.

171. (566) **Indian Lorikeet**
***Loriculus vernalis* (Sparrman)**

Common resident and local migrant in considerable to large numbers. More common in the coastal belt at the tail-end of the monsoon, August to October, and in the Ghats during the winter (November to March); uncommon in both zones in the monsoon.

172. (571) **Pied Crested Cuckoo**
***Clamator jacobinus* (Boddaert)**

A not uncommon but capricious visitor, in small numbers, to the coastal lowlands and plateaus of the midlands up to the base of the Western Ghats, from early June to end November.

173. (573) **Common Hawk-Cuckoo**
***Cuculus varius* Vahl**

Uncommon summer visitor in small numbers. Essentially a bird of the plateaus, their scarps and the base and foothills of the Western Ghats. Usually present from mid-March to early November.

174. (576) **Indian Cuckoo**
***C. micropterus* Gould**

Rare visitor. Recorded by Grubh and Ali (1975) at Cotigao WS, in November-December, and myself at the base of the Sahyadris, from March to May.

175. (578) **Cuckoo *C. canorus* Linn.**

Up to 1996, I had only three records, all from slightly hilly parts of the coastal belt. Curiously, I came across the cuckoo on October 9, 10 and 11, with two years intervening between each date. This strongly suggests a short and extremely punctual passage migration. However, 1996 seems to have been an 'invasion year': suddenly, from early October till the first days of November, dozens of these cuckoos dotted electric lines all over Goa, from just behind the seashore to the foot of the Western Ghats.

176. (582) **Indian Banded Bay Cuckoo**
***C. sonneratii* (Latham)**

Rare resident in very small numbers. Occurs on scarps of midland plateaus and at the base of the Ghats. Breeding, with the common iora as host, was recorded in October.

177. (584) **Indian Plaintive Cuckoo**
***C. passerinus* (Vahl)**

A fairly common summer visitor, in small numbers, to all three zones. Starts to arrive in early May and fades away towards mid-November with an occasional stray being recorded in January, March to April.

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178. (588) **Drongo Cuckoo**
***Surniculus lugubris* (Horsfield)**

An uncommon summer (monsoon) visitor in small numbers, preferring well-wooded scarps of midland plateaus and the base and outlying hills of the Ghats, from late May to early October.

179. (590) **Koel**
***Eudynamys scolopacea* (Linn.)**

Common resident, in large numbers, from the coast to Ghats. Fledglings were recorded from November to May.

180. (595) **Small Green-billed Malkoha**
***Rhopodytes viridirostris* (Jerdon)**

Uncommon dry season visitor in small numbers. This cuckoo inhabits cashew-covered plateaus, midland as well as coastal, and their scarps. Though it seems to avoid the Western Ghats strip, I have come across a sizeable population on Vagheri (*ca* 760 m), an outlying hill in Sattari taluka, where it occurs even on the summit. Not yet recorded from mid-June to early September.

181. (600) **Coucal**
***Centropus sinensis* (Stephens)**

Common, ubiquitous (wherever cover is found) and numerous resident from the coast to the Ghats. Fledglings were seen in October.

182. (605) **Lesser Coucal**
***C. toulou* (P.L.S. Muller)**

Davidson (1898) felt 'certain I have also seen it at Anshi. Mr. Aitken has also seen it at Castle Rock still further north'. Both locations are on the crest of the Sahyadris, just a few km from the Goa border. I have only one unambiguous sight record of a single bird on the fringes of a cashew plantation surrounded by evergreen and moist deciduous forest in the BMWS, hardly 7 km from Castle Rock.

183. (606) **Barn Owl *Tyto alba* (Scopoli)**

Breeding resident in small numbers. The few records I know of are all from Panaji, Goa's capital, and surrounding villages.

184. (623) **Collared Scops Owl**
***Otus baccamoena* Pennant**

A not uncommon resident, in small numbers, of the coastal belt; rare at the base and slopes (up to 250 m) of the Ghats.

185. (628) **Forest Eagle Owl**
***Bubo nipalensis* Hodgson**

I have seen this owl only thrice, in March 1985 and 1989, and in May 1996, each time within a radius of half a km of the Devil's Canyon, in the BMWS.

186. (630) **Dusky Horned Owl**
***B. coromandus* (Latham)**

There are two records, dated June 1986 and January 1996, from densely forested gullies on the scarp of plateaus in close proximity to the coast, at Tirakol (Pernem) and Arpora (Bardez).

187. (631) **Brown Fish Owl**
***B. ceylonensis* (Gmelin)**

Uncommon resident, in small numbers, of remnant semi-evergreen forest on the slope of plateaus facing the coastal strip (from where this owl forays into estuaries and disused saltpans). It also inhabits well-watered forests on the lower slopes of the Ghats. One bird was shot by an irate fisherman, less than 200 m from the sea, at Tirakol (Pernem).

188. (636) **Jungle Owlet**
***Glaucidium radiatum* (Tickell)**

A common, moderately numerous resident of the coastal belt and midlands up to the base of the Western Ghats. Fledglings were seen in May and July.

189. (642) **Brown Hawk Owl**
***Ninox scutulata* (Raffles)**

I have three dry season records, spread over 5 years, from outlying hillocks of the Sahyadri foothills.

190. (652) **Spotted Owlet**
***Athene brama* (Temminck)**

A common and numerous resident throughout Goa; seems to favour the coastal belt. Fledglings were seen in March.

191. (659) **Brown Wood Owl**
***Strix leptogrammica* Temminck**

A pair bred and successfully reared one young between February and June 1986, in a patch of remnant semi-evergreen forest on a

plateau scarp close to the coast, at Arpora (Bardez). Not recorded before or since.

192. (669) **Great Eared Nightjar *Eurostopodus macrotis* (Vigors)**

Grubh and Ali (1975) 'regularly heard (them) at dusk' around Valpoi (Sattari) in November-December 1972. I heard this nightjar at Pali, near Valpoi, in February 1985.

193. (671) **Indian Jungle Nightjar *Caprimulgus indicus* Latham**

Common, moderately numerous resident (or dry season visitor, there are no records between mid-May and mid-September) of plateaus near the coast to the base of the Ghats.

194. (675) **Long-tailed Nightjar *C. macrurus* Horsfield**

Grubh and Ali (1975) collected a specimen in or around the Cotigao WS, in November-December 1972. I remember having heard one in the late seventies from a then undisturbed valley of remnant semi-evergreen woods at Bambolim (Tiswadi), in the plateau region.

195. (682) **Franklin's Nightjar *C. affinis* Horsfield**

A specimen was collected in Cotigao WS by Saha and Dasgupta (1992), in Feb. 1978. Frost sighted one on the wooded slope of a plateau at Arpora (Bardez), close to the coast, in Feb. 1997.

196. (685) **Indian Edible-nest Swiftlet *Collocalia unicolor* (Jerdon)**

A common, year-round visitor in large though wildly fluctuating numbers. May be encountered anywhere in Goa, but most frequently in a *ca*. 5 km deep strip along the coast. Their two-directional flight pattern (southward at dawn and northward at dusk) strongly suggests that they originate from the vast breeding colony on Burnt Island off Malwan (Sindhudurg dist., Maharashtra), *ca*. 30 km north of Goa. Flock size peaks in December-January with up to 1500 birds, while between May and September singles and small groups prevail. Numbers have declined sharply since 1989, when commercial exploitation of the Burnt Island colony recommenced.

This swiftlet used to breed in caves which have now collapsed, on Anjediva, a small island to the southwest off Karwar (North Kanara) which is Goan territory. There might still be a small breeding population in the Goan Western Ghats.

197. (691) **Large Brown-throated Spinetail Swift *Chaetura gigantea* (Temminck)**

In March 1985, I saw 5 birds cruising over an outlying hillock of the Sahyadris, at Kalay (Sanguem). Visiting British birdwatchers claim to have sighted up to 25 birds at Chandranath hill (Quepem) and the Dudhsagar waterfalls in the BMWS, in Nov. 1994 (Willoughby 1996).

198. (692) **White-rumped Spinetail *C. sylvatica* (Tickell)**

Uncommon visitor or resident, in small numbers, of the BMWS (up to 24 birds) and Cotigao WS (up to 8). Unrecorded from July to November.

199. (693) **Alpine Swift *Apus melba* (Linn.)**

Straggler. There are 5 winter records spanning 7 years, of rabbles of up to 40 birds from two localities where midland plateaus border on the coastal belt.

200. (699) **Large White-rumped Swift *A. pacificus* (Latham)**

Davidson (1898) found 'This is the common Kanara swift ... I have seen it in considerable numbers on the ridge of the Ghats close to the Dudh Sagar station of the Portuguese railway at all seasons ...'

At the end of Oct. 1996 and again a week later, a group of at least 4 birds put in several fleeting appearances at the Carambolim (Tiswadi) lake and the nearby Cumbarjua canal.

201. (703) **House Swift *A. affinis* (J.E. Gray)**

A common, considerably numerous resident from the coast to the crest of the Ghats, this swift breeds throughout the year in towns, under bridges and in the numerous tunnels piercing the steep escarpments along the Braganza Ghat section of the former Western India Portuguese-guaranteed Railway.

202. (707) **Palm Swift**
***Cypsiurus parvus* (Lichtenstein)**

Not uncommon, but very local resident, in moderate numbers. Found mainly in the coastal belt wherever a sprinkling of borassus palm occurs, often in municipal gardens. Breeds in September.

203. (709) **Crested Tree Swift**
***Hemiprocne longipennis* (Rafinesque)**

A rather uncommon, considerably numerous resident of the base of the Western Ghats and plateau scarps in the midlands. Roving singles and small groups may appear anywhere between the seashore and the crest of the Sahyadris. Breeding was recorded in April.

204. (712) **Malabar Trogon**
***Harpactes fasciatus* (Pennant)**

Uncommon resident, in considerable numbers, of the Western Ghats. Evenly distributed from the moist deciduous forests at the base through the wet evergreen jungle slopes to the crest.

205. (719) **Lesser Pied Kingfisher**
***Ceryle rudis* (Linn.)**

Not uncommon, moderately numerous resident of various water-bodies in the coastal belt and river basins; rare along the coast and marshes at the base of the Ghats.

206. (722) **Common Kingfisher**
***Alcedo atthis* (Linn.)**

A common, considerably numerous resident, found throughout the area from rocky seashore to the crest of the Sahyadris. Breeds in the coastal belt between May and July, in the Ghats probably in October.

207. (725) **Blue-eared Kingfisher**
***A. meninting* Horsfield**

Small numbers of this rather scarce resident occur on not too fast flowing stretches of rivers and streams in the foothills and on the crest of the Sahyadris.

208. (727) **Three-toed Kingfisher**
***Ceyx erithacus* (Linn.)**

Status uncertain; possibly a very rare monsoon visitor to the base and lower slopes of the Western Ghats. Rane (1982) recorded it between April and June 1982 at Collem and Mollem (Sanguem). There are two July records, in 1988 and 1996, from the same area.

209. (730) **Stork-billed Kingfisher**
***Pelargopsis capensis* (Linn.)**

Not uncommon, moderately numerous resident, from rocky seashore, creeks and saltpans to rivers in the Ghats foothills up to 150 m.

210. (735) **White-breasted Kingfisher**
***Halcyon smyrnensis* (Linn.)**

A common, ubiquitous resident in considerable to large numbers. Occurs from the seashore to the Ghats foothills. Breeding was noted in April and in the monsoon.

211. (739) **Black-capped Kingfisher**
***H. pileata* (Boddaert)**

Small numbers of this rather uncommon resident (?) or dry season visitor are found along the seashore, mangrove-lined creeks, inland estuaries and on the upper reaches of the rivers where they penetrate the Western Ghats (several records from the bottom and top of the Dudhsagar waterfalls, at *ca.* 170 and 520 m). It is absent from June to September.

212. (740) **White-collared Kingfisher**
***H. chloris* (Boddaert)**

Status uncertain. Visiting British bird-watchers on crocodile-watching trips to the Cumbarjua canal, a natural, mangrove-fringed creek linking the inland estuaries of the Zuari and Mandovi rivers, reported sightings of this kingfisher from 1993 onwards. Frost, Manville and I confirmed these reports in November 1996. Another sighting of two birds dates from April 1997.

213. (744) **Chestnut-headed bee-eater**
***Merops leschenaulti* (Vieillot)**

Not uncommon, considerably numerous resident of the base and lower slopes of the Western Ghats and of the eastern rim of the midland plateau. The numbers of this bird are in a steep and steady decline since the mid-eighties, especially at BMWS, where till 1985

up to 200 individuals could be found at a night-roost just outside Collem village (Sanguem).

214. (748) **Blue-tailed Bee-eater**
***M. philippinus* Linn.**

Fairly common, dry season visitor in large numbers that wildly fluctuate annually. Patchily distributed from river mouths to clearings in the forests of the lower Ghats, from early September to the first days of May.

215. (750) **Green Bee-eater**
***M. orientalis* Latham**

A very common, very numerous dry season visitor to the entire state, from beaches to the crest of the Sahyadris. Numbers start dwindling in March, augmented shortly by passage migrants in May. Only a few remain over the heavy monsoon in June to August.Return migration in early September. Every dry spell in the monsoon brings an influx of these birds, indicating that they had not migrated farther than the Deccan plateau, just across the ridge of the Sahyadris.

216. (753) **Blue-bearded Bee-eater**
***Nyctiornis athertoni* (Jardine & Selby)**

Rare resident in very small numbers. There are 7 records, covering all seasons, from the lower reaches (up to 200 m) and outlying hills of the Western Ghats.

217. (754) **European Roller**
***Coracias garrulus* Linn.**

A record by Davidson (1898) from Majali (N. Kanara), just a few km south of Goa, seems to be the southernmost of this species in India. Grubh and Ali (1975) procured a specimen from the almost adjoining Cotigao WS, in November-December 1972. A bird killed in a collision with an aircraft, 30 nautical miles off Goa, in October 1987, was reported by Satheesan (1988).

October-November 1996 saw a veritable invasion of this species into Goa: up to 4 birds were recorded from an alluvial plain at Divar (Tiswadi) Island in the inland estuary of the Mandovi, and from a grassland between Mollem and Collem (Sanguem), at the base of the Ghats.

218. (759) **Indian Roller**
***C. benghalensis* (Linn.)**

Common, considerably numerous winter visitor from just behind the seashore to the foot of the Sahyadris, from mid-October to early April Numbers are declining steadily.

219. (763) **Hoopoe *Upupa epops* Linn.**

Moderate to considerable numbers of this not uncommon winter visitor are spread over the whole area, from offshore islands (during migration) to the base of the Ghats, between mid-October and late April.

220. (768) **Malabar Grey Hornbill**
***Tockus griseus* (Latham)**

A fairly common, considerably numerous resident of the Sahyadris, from the outlying hillocks to the crest; apparently never strays from this rather restricted habitat.

221. (775) **Malabar Pied Hornbill**
***Anthracoceros coronatus* (Boddaert)**

Moderate numbers of this not uncommon resident occur mainly in the Western Ghats and the eastern part of the midlands. Roving birds occasionally appear even at the coast.

222. (776) **Great Pied Hornbill**
***Buceros bicornis* Linn.**

Status uncertain; possibly a very rare resident. The fact that Grubh and Ali (1975) noted this bird at the BMWS and saw three specimens at the Cotigao WS within two weeks in late 1972, while I encountered it just four times in 1980-1997 shows how endangered this species has become. Three of my sightings are from the BMWS, one (of 6 birds) is from the coastal village of Tirakol (Pernem).

223. (782) **Large Green Barbet**
***Megalaima zeylanica* (Gmelin)**

Uncommon resident in small to moderate numbers. Sporadically found all over the area, but mainly at the base of the Western Ghats.

224. (785) **Small Green Barbet**
***M. viridis* (Boddaert)**

Common resident in large numbers. Evenly distributed over the entire study area, from seaside palm groves to the dense wet

evergreen forests on the upper slopes and crest of the Sahyadris. Breeding in February.

225. (790) **Crimson-throated Barbet *M. rubricapilla* (Gmelin)**

Considerable numbers of this fairly common resident occur along the eastern rim of the midland region and the base and lower slopes of the Western Ghats.

226. (792) **Crimson-breasted Barbet *M. haemacephala* (P.L.S. Muller)**

A common, numerous resident from the coast to the forests on the lower slopes of the Sahyadris up to *ca*. 150 m. Breeding in January.

227. (796) **Wryneck *Jynx torquilla* Linn.**

Stray. Recorded in November 1986 by myself and in March 1993 by Willoughby (1996), both from the same area in the coastal belt of North Goa.

228. (798) **Speckled Piculet *Picumnus innominatus* Burton**

Stray (?). A single bird was observed in bamboo clusters at the foot of the Anmod Ghat (BMWS), in November 1996, by me and Frost.

229. (804) **Rufous Woodpecker *Micropternus brachyurus* (Vieillot)**

Fairly common, considerably numerous resident of the coastal belt and the midland region, up to the base of the Ghats.

230. (816) **Small Yellow-naped Woodpecker *Picus chlorolophus* Vieillot**

A scarce resident, in very small numbers, of the Sahyadris, from the base to the ridge.

231. (819) **Lesser Golden-backed Woodpecker *Dinopium benghalense* (Linn.)**

This common, considerably numerous resident is distributed through all three zones, from palm groves at the shore to the upper reaches of the Ghats. Breeding in April and December.

232. (825) **Indian Golden-backed Three-toed Woodpecker *D. javanense* (Ljungh)**

Not uncommon, moderately numerous resident of moist deciduous and wet evergreen forest of the Western Ghats, from the foothills to the crest.

233. (830) **Indian Great Black Woodpecker *Dryocopus javensis* (Horsfield)**

Very small numbers of this scarce resident are found in moist deciduous and semi-evergreen forest at the base of the Sahyadris.

234. (847) **Yellow-fronted Pied Woodpecker *Picoides mahrattensis* (Latham)**

Uncommon resident, in small numbers, of the foothills and lower slopes of the Western Ghats. Occasional visitor to remnant patches of semi-evergreen woods near the sea.

235. (851) **Pigmy Woodpecker *P. nanus* (Vigors)**

Not uncommon resident, in moderate numbers. Restricted to the moist deciduous and semi-evergreen forests of the Sahyadris foothills up to *ca*. 150 m.

236. (856) **Heart-spotted Woodpecker *Hemicircus canente* (Lesson)**

Moderate numbers of this fairly common resident occur in the entire Western Ghats of Goa. Breeding in January.

237. (861) **Larger Golden-backed Woodpecker *Chrysocolaptes lucidus* (Scopoli)**

Fairly common, considerably numerous resident of the Western Ghats base and foothills up to *ca*. 250 m).

238. (867) **Indian Pitta *Pitta brachyura* (Linn.)**

A fairly common, considerably numerous dry season and breeding visitor. Found from the hinterland of the seashore to the lower slopes of the Ghats, from end April to early September. There is an irregular, enigmatic appearance of a few passage migrants between early January and mid-March.

239. (878) **Ashy-crowned Finch-Lark *Eremopterix grisea* (Scopoli)**

A fairly common, considerably numerous, dry season visitor to coastal and riverine lowlands and lateritic plateaus not far from the coast. Absent from the first days of June to late September.

240. (882) **Rufous-tailed Finch-Lark *E. phoenicurus* (Franklin)**

Uncommon dry season visitor, possibly

resident, in small numbers, at a few places in the Mandovi river basin. Not recorded in the rains.

241. (886) **Short-toed Lark**
***Calandrella cinerea* (Gmelin)**

A locally common, winter visitor in very large numbers, typically on alluvial lowlands of the coastal belt and river basins, lateritic plateaus in proximity to the sea and grasslands at the foot of the Sahyadris. This migrant starts arriving in late September and disappears by early April.

242. (901) **Malabar Crested Lark**
***Galerida malabarica* (Scopoli)**

A common, monsoon-shirking resident, in large numbers, of the coastal belt and midland region; uncommon winter visitor in small numbers to the base of the Western Ghats. Monsoon evasion begins in April, by late May the last birds have left; return movement peaks in end-August. Breeding was noted in October-November on a coastal plateau.

243. (902) **Sykes's Crested Lark**
***G. deva* (Sykes)**

Stray. There were a number of sightings over a 10-day period in early Dec. 1996, on wasteland and pastures near tidal creeks in coastal N. Goa, by Frost, Manville and myself.

244. (907) **Eastern Skylark**
***Alauda gulgula* Franklin**

A fairly common resident in considerable numbers. Prefers lateritic plateaus in close proximity to the sea and alluvial land in the river basins. There is much seasonal shifting.

245. (910) **Collared Sand Martin**
***Riparia riparia* (Linn.)**

Stray. One or two birds were seen hawking over a barren laterite plateau of the coastal belt, near a freshwater reservoir, at the end of September 1997.

246. (913) **Crag Martin**
***Hirundo rupestris* Scopoli**

Small numbers of this scarce winter visitor (mid-November to March) occasionally seen at cliffs on the upper slopes of the Sahyadris.

247. (914) **Dusky Crag Martin**
***H. unicolor* Sykes**

A not uncommon, moderately numerous resident of the Western Ghats and, to a lesser degree, the eastern midlands. Hundreds of migrants appear in some years during November. Rane (1982) recorded this martin in June at Panaji, Goa, at the mouth of the Mandovi. Breeding was recorded in February and August-September

248. (916) **Swallow *H. rustica* Linn.**

Not uncommon, moderately numerous winter visitor to the coastal belt and river basins, between mid-September and late March.

249. (919) **House Swallow**
***H. tahitica* Gmelin**

Vagrant. Frost and Manville (*pers. comm.*) observed a single bird perched along with *H. daurica* on an electric line over pastureland at the coastal village of Candolim (Bardez), on two consecutive days in late March 1997.

250. (921) **Wire-tailed Swallow**
***H. smithii* Leach**

This common, moderately numerous resident is found all over the territory, from offshore islands to rivers in the foothills of the Ghats. Breeding was recorded in February-March in the Ghats and during August in the coastal belt.

251. (922) **Indian Cliff Swallow**
***H. fluvicola* Blyth**

An uncommon, somewhat irregular winter visitor, in very moderate numbers, to the coastal belt. Most records fall between late October and mid-March.

252. (923) **Red-rumped Swallow**
***H. daurica* Linn.**

An uncommon resident in small numbers, but very common winter visitor in very large numbers. Distributed over the entire study area. The winter visitors disappear by mid-April, leaving a tiny resident population in the coastal region, where nest-building was noticed in late April. Large flocks of the migratory population reappear in mid-October.

253. (930) **House Martin**
***Delichon urbica* (Linn.)**

Straggler. Between late Dec. 1995 and mid-Feb. 1996, I saw up to 4 birds on three occasions, at coastal headlands and the base of the Ghats.

254. (946) **Rufous-backed Shrike**
***Lanius schach* Linn.**

A common, considerably numerous, dry season visitor to all zones, from just behind the seashore to the lower slopes of the Sahyadris. It moves out by end-April (most probably up to the Deccan, where it is common during its absence from Goa) and returns in mid-September when the rains are almost over.

255. (949) **Brown Shrike *L. cristatus* Linn.**

Small numbers of this rather scarce winter visitor are found between mid-October and early February in an amazing variety of habitats, from stands of beach-side casuarinas over gardens, pasture land, fallow rice-paddies and mangroves, along creeks, to dense evergreen forest on the scarp of the Ghats.

256. (952) **Golden Oriole**
***Oriolus oriolus* (Linn.)**

A common dry season visitor in large and passage migrant in very large numbers. Spread all over, from just behind the sea-shore to the lower reaches of the Sahyadris, between early or mid-September and mid-May.

257. (954) **Black-naped Oriole**
***O. chinensis* Linn.**

Stray. A pair was sighted in November 1985 in BMWS and a single female twice in December 1996 in the Cotigao WS.

258. (958) **Black-headed Oriole**
***O. xanthornus* (Linn.)**

This common, numerous resident inhabits plateau-scarps (even close to the sea) and the belt of moist deciduous forests at the foot of the Ghats, where it outnumbers all other bird species in May. Breeds in April, possibly August-September.

259. (963) **Black Drongo**
***Dicrurus adsimilis* (Bechstein)**

A common, numerous resident and local migrant. Occurs in all zones, from rice-paddies behind the seashore to village outskirts at the foot of the Ghats. The greater part of the population moves out (presumably up to the Deccan) in late May and returns towards end July.

260. (965) **Grey Drongo**
***D. leucophaeus* Vieillot**

Common winter visitor in large numbers, from seaside mango orchards to the ridge of the Sahyadris. This most punctual of all winter visitors arrives in the first week of October and has left by early April.

261. (967) **White-bellied Drongo**
***D. caerulescens* (Linn.)**

A not uncommon, moderately numerous resident of the midland region and the base and lower slopes of the Ghats. Breeding in April.

262. (971)**Bronzed Drongo**
***D. aeneus* Vieillot**

Common resident, in considerable numbers, of the entire Western Ghats and in moderate numbers of many remnant pockets of semi-evergreen forest on plateau scarps, even close to the sea. Breeds in April-May.

263. (973) **Hair-crested Drongo**
***D. hottentotus* (Linn.)**

Scarce winter visitor in very small numbers. There are three records each from the Cotigao WS and BMWS and one from Valpoi (Sattari), all in November to January.

264. (977) **Greater Racket-tailed Drongo**
***D. paradiseus* (Linn.)**

A common, considerably numerous resident of the Western Ghats and their outlying hills and better-wooded valleys of the midland region; also occasional visitor to patches of evergreen woods on the west facing scarps of plateaus near the coast. Breeds April to June.

For a discussion of the validity of a specimen of the Ceylon subspecies *D. p. lophorinus* (Vieillot), collected in Goa, see Ripley (1981). More recently, Saha and Dasgupta (1992) procured a specimen of this race from Poinguinim (Canacona) and describe it as 'not common in sal and cashew plantations'.

265. (982) **Ashy Swallow-Shrike**
***Artamus fuscus* Vieillot**

Not uncommon but capricious resident in moderate numbers, monsoon visitor in considerable numbers. Found in all zones. Absent from large tracts during the dry season. Most common at the foot of the Sahyadris, where loose flocks of more than 80 are not uncommon at villages like Mollem and Collem (Sanguem).

266. (987) **Grey-headed Myna**
***Sturnus malabaricus* (Gmelin)**

Fairly common, dry season visitor in varying, often large numbers, from the seashore (where they prefer night roosts in coconut palms) to the secondary forests of the lower reaches of the Ghats. The coastal belt is frequented almost exclusively by the nominate race, with a few specimens of *S. m. blythii* (Jerdon) showing up during autumn migration, Aug. to Oct. Further inland and along the Ghats, subsp. *blythii* is predominant, with pure flocks of *S. m. malabaricus* (Gmelin) appearing only in May. Hybrids of the two races are common in all zones.

267. (994) **Black-headed Myna**
***S. pagodarum* (Gmelin)**

Rather scarce and irregular winter visitor, in very small numbers, to coastal villages of N. Goa, between early October and March.

268. (996) **Rosy Pastor *S. roseus* (Linn.)**

Not uncommon winter visitor in annually fluctuating numbers, from a few smallish groups in some years to flocks up to 2000 in others. Found on coastal lowlands and plateaus, rarely at the base of the Ghats, from end-October (unusual in mid-September) to mid-March.

269. (1006) **Common Myna**
***Acridotheres tristis* (Linn.)**

The only moderately numerous resident population is augmented in mid-May by local migrants; every spell of heavy rainfall in June-July brings a new influx till it is almost as common and numerous as *A. fuscus*, in July-August. These summer visitors disappear by early October.

270. (1008) **Bank Myna**
***A. ginginianus* (Latham)**

In the early eighties, a shanty town sprang up at Zuarinagar (Marmagoa) and with it a population of bank mynas, probably spawned by escaped cage-birds. The population peaked with over 400 birds in 1985-86; by the end of 1996 it had dwindled to less than 10.

271. (1009) **Jungle Myna**
***A. fuscus* (Wagler)**

Very common, ubiquitous resident, in large numbers, of the coastal belt and the midland region right up to the Western Ghats foothills. Breeds from April to June.

272. (1015) **Hill Myna**
***Gracula religiosa* (Linn.)**

Scarce, very local resident in small numbers. One group of less than 15 individuals frequents the dense evergreen forest around a tiny hamlet in the BMWS, at *ca* 160 m; another clan of over 20 birds roams the riverine forests of the Cotigao WS.

273. (1032) **Indian Tree Pie**
***Dendrocitta vagabunda* (Latham)**

Roving groups of this common, considerably numerous resident are encountered from coastal villages to the base of the Western Ghats.

274. (1049) **House Crow**
***Corvus splendens* Vieillot**

Very common, ubiquitous resident in very large numbers from offshore islets to hill tribe hamlets in the jungles at the foot of the Ghats. Breeds throughout the year, except in the monsoon.

275. (1054) **Jungle Crow**
***C. macrorhynchos* Wagler**

An uncommon, moderately numerous resident, liable to turn up anywhere from just behind the beaches to the tiniest clearing in the dense evergreen forests on the ridge of the Sahyadris.

276. (1065) **Pied Flycatcher-Shrike**
***Hemipus picatus* (Sykes)**

Not uncommon, moderately numerous resident of remnant semi-evergreen woods at the

scarp of plateaus and of the lower reaches of the Western Ghats (up to *ca* 180 m). Breeding in March-April.

277. (1068) **Large Wood Shrike**
***Tephrodornis virgatus* (Temminck)**

An uncommon resident in considerable numbers (less during monsoon). Found on the outlying hills and lower slopes (up to *ca* 250 m) of the Ghats.

278. (1070) **Common Wood Shrike**
***T. pondicerianus* (Gmelin)**

In its rather restricted woodland habitat, a not uncommon bird; resident, in considerable numbers, from coastal villages to the base of the Sahyadris.

279. (1072) **Large Cuckoo-Shrike**
***Coracina novaehollandiae* (Gmelin)**

This rather uncommon resident is thinly spread over all three zones, from coastal villages to the lower slopes of the Ghats.

280. (1078) **Black-headed Cuckoo-Shrike**
***C. melanoptera* (Ruppell)**

This not uncommon, moderately numerous resident is mainly found in valleys on the scarp of plateaus in the midland region, rarely on the slopes of the Western Ghats.

281. (1081) **Scarlet Minivet**
***Pericrocotus flammeus* (Forster)**

Common, considerably numerous resident of the Western Ghats, from outlying hillocks and foothills to the crest.

282. (1089) **Rosy Minivet**
***P. roseus* (Vieillot)**

Stray. A specimen was collected by Grubh and Ali (1975) in Canacona taluka, S. Goa, in November-December 1972.

283. (1093) **Small Minivet**
***P. cinnamomeus* (Linn.)**

A not uncommon, considerably numerous resident of woodlands in all three zones; rather scarce on the upper slopes of the Ghats. Breeding in October and December.

284. (1098) **Common Iora**
***Aegithina tiphia* (Linn.)**

Generally common resident in considerable numbers. Distributed throughout the territory; uncommon in the forests of the Sahyadris.

285. (1103) **Goldfronted Chloropsis**
***Chloropsis aurifrons* (Temminck)**

Fairly common, considerably numerous resident of all zones, from wooded coastal villages to the upper slopes of the Ghats. Breeding in January-February.

286. (1108) **Gold-mantled Chloropsis**
***C. cochinchinensis* (Gmelin)**

A fairly common resident, in considerable numbers, of well-wooded localities, ranging from mango groves in seaside villages to evergreen forest on the scarp of the Ghats. Breeding in July and September.

287. (1109) **Fairy bluebird**
***Irena puella* (Latham)**

Common, considerably numerous resident of the Western Ghats foothills to crest. Also found on some hillocks on the eastern rim of the midland region (e.g. Mayem lake) and hardly 50 m from the sea, at Cabo de Rama (Canacona), where a spur of the Sahyadris juts into the Arabian Sea. At the height of the monsoon, the fairy bluebird is often the dominant bird species of the Ghat forests.

288. (1114) **Grey-headed Bulbul**
***Pycnonotus priocephalus* (Jerdon)**

A common resident, in considerable numbers, of the scarps of coastal headlands and plateaus of the midlands, and of the entire Ghats up to the crest.

289. (1116) **Black-headed Yellow Bulbul**
***P. melanicterus* (Gmelin)**

The ruby-throated race *P. m. gularis* (Gould) is a common, considerably numerous resident, found in the Western Ghats from outlying hills and the base to *ca* 550 m; not yet recorded from the crest. Grubh and Ali (1975) collected 4 specimens of this bird in the BMWS in 1972 which, according to them, confirmed the occurrence of this bulbul in Goa (doubted in the Handbook Vol. 6: 73). Meanwhile, the Goa Government went a step further and promoted

this beautiful and unobtrusive bulbul to the questionable status of 'State Bird' of Goa.

290. (1120) **Red-whiskered Bulbul**
***P. jocosus* (Linn.)**

Very common, resident in large to very large numbers. Ubiquitous in all zones. Breeding season in the Ghats May-June, in the midland region July-October.

291. (1128) **Red-vented Bulbul**
***P. cafer* (Linn.)**

Common resident in large numbers, found throughout the plateau region up into the foothills of the Ghats. Breeding in May.

292. (1138) **White-browed Bulbul**
***P. luteolus* (Lesson)**

A fairly common, considerably numerous resident of the midland region, from sea-facing plateaus to the base of the Ghats. This bulbul, essentially a bird of scrub and cashew-covered plateaus and their scarps, is occasionally also found in mangroves lining coastal creeks.

293. (1144) **Yellow-browed Bulbul**
***Hypsipetes indicus* (Jerdon)**

Very common, ubiquitous resident, in large numbers, of the entire Goan Western Ghats, foothills to crest. By far the most common bird there, in all forest types.

294. (1148) **Black Bulbul**
***H. madagascariensis* (P.L.S. Muller)**

A common, numerous dry season visitor on the ridge of the Ghats. Roving groups descend frequently to the lower reaches. This monsoon fugitive absents itself from mid-May to end-October, presumably by moving further inland.

295. (1154) **Spotted Babbler**
***Pellorneum ruficeps* Swainson**

Fairly common, considerably numerous resident of well-wooded localities in all zones, from gardens in seaside villages to the ridge of the Ghats. Breeds in June-July.

296. (1173) **Slaty-headed Scimitar Babbler**
***Pomatorhinus horsfieldii* Sykes**

Uncommon resident. Singles and small groups of up to 5 birds were noted, in all seasons, on the crest of the Sahyadris and, occasionally, down to an altitude of *ca* 70 m. Davidson (1898) had 'obtained fully incubated eggs in October at Castle Rock', a few km from the Goa border.

297. (1222) **Rufous-bellied Babbler**
***Dumetia hyperythra* (Franklin)**

A rather scarce, erratic visitor in all seasons. Roving groups of up to a dozen were seen between 1981 and 1986 on the scarps of plateaus facing the coastal strip. They resurfaced again in March 1995, when Frost (*pers. comm.*) had several sightings of small groups in the same locality.

298. (1224) **Black-headed Babbler**
***Rhopocichla atriceps* (Jerdon)**

Common, considerably numerous resident of the Western Ghats slopes and outlying hills; rarely encountered at the base. Breeding in Dec.

299. (1231) **Yellow-eyed Babbler**
***Chrysomma sinense* (Gmelin)**

A minuscule, but apparently steady, resident population of probably less than 10 birds exists on a coastal lateritic plateau at Tirakol (Pernem), Goa's northernmost village.

300. (1259) **Rufous Babbler**
***Turdoides subrufus* (Jerdon)**

An uncommon resident, in small numbers, of the upper slopes and the ridge of the Ghats, occasionally descending to *ca* 150 m.

301. (1265) **Jungle Babbler**
***T. striatus* (Dumont)**

A common resident, in large numbers, of the coastal and midland regions up to the foothills of the Sahyadris.

302. (1287) **Rufous-vented Laughing Thrush**
***Garrulax delesserti* (Jerdon)**

An uncommon resident (?) in moderate numbers, on the crest of the Western Ghats. I have seen flocks at and around the top of the Dudhsagar waterfalls (in the BMWS) in January, February, April and October Davidson (1898) 'found it only ... along the Goa frontier, from Castle Rock to Anshi, where it goes about in large flocks'.

303. (1309) **White-breasted Laughing**
Thrush *G. jerdoni* Blyth

Recorded at the Dudhsagar waterfalls by

Rane (1982) in June. He also noted 'large flocks of 30 to 40 at Castle Rock', just across the border.

304. (1390) **Quaker Babbler**
***Alcippe poioicephala* (Jerdon)**

Common resident in large numbers. Roving flocks may turn up at any well-wooded locality, from seaside villages to the ridge of the Ghats. Breeding in May.

305. (1407) **Brown Flycatcher**
***Muscicapa latirostris* Raffles**

A not uncommon, moderately numerous winter visitor, from mid-October to end-April Found in all zones, from rocky offshore islets (during autumn migration) to mango groves in coastal villages and dense forest on the crest of the Ghats. A few records from June indicate the possibility of this flycatcher being also a resident in the Western Ghats section.

306. (1408) **Brown-breasted Flycatcher**
***M. muttui* (Layard)**

Scarce, irregular winter visitor in very small numbers. Recorded in the Sahyadris, from the foothills to the crest, between Dec. and Feb.

307. (1409) **Rufous-tailed Flycatcher**
***M. ruficaudata* Swainson**

Rare winter visitor, in very small numbers, to remnant semi-evergreen forest on plateau scarps facing the coastal strip, and to the base and ridge of the Ghats, between October-January.

308. (1411) **Red-breasted Flycatcher**
***M. parva* Bechstein**

A fairly common and considerably numerous winter visitor to all zones. Extremely punctual, regular arrival in mid-October; it leaves by the first week of April at the latest.

309. (1421) **White-browed Blue Flycatcher**
***M. superciliaris* Jerdon**

Grubh and Ali (1975) collected a specimen in BMWS, in November-December 1972. There are no other records.

310. (1435) **White-bellied Blue Flycatcher**
***M. pallipes* Jerdon**

Uncommon resident in small numbers, occurs exclusively in the Western Ghats, from the foothills to the crest. Breeds between April-August.

311. (1440) **Blue-throated Flycatcher**
***M. rubiculoides* (Vigors)**

A specimen was collected by Grubh and Ali (1975) in the Valpoi (Sattari) area, in November-December 1972. Frost (*pers. comm.*) observed a pair in a patch of remnant semi-evergreen forest bordering the coastal strip, at Arpora (Bardez), in early January 1997.

312. (1442) **Tickell's Blue Flycatcher**
***M. tickelliae* (Blyth)**

Common resident in large numbers, from gardens and groves in coastal villages to moist deciduous forests at the base of the Sahyadris; rare on the higher slopes. Breeding in September.

313. (1445) **Verditer Flycatcher**
***M. thalassina* Swainson**

Rather scarce, but regular winter visitor in small numbers. Ranges from patches of remnant semi-evergreen woods in coastal villages to the heavy forests on the ridge of the Ghats. Appears at the beginning of November and has left by February-end.

314. (1449) **Grey-headed Flycatcher**
***Culicicapa ceylonensis* (Swainson)**

Stray. In January 1986, I observed one bird at a stream in dense evergreen forest, at the base of the Dudhsagar waterfalls, in the BMWS. Willoughby (1996) noted a single in the Bondla WS, in November 1995.

315. (1455) **White-browed Fantail Flycatcher *Rhipidura albicollis* (Vieillot)**

The subspecies *R. a. albogularis* (Lesson) is a common, considerably numerous resident of most wooded localities in all three zones, from seaside gardens and mangrove forest in the river basins to the slope of the Sahyadris, where it is rare.

316. (1461) **Paradise Flycatcher**
***Terpsiphone paradisi* (Linn.)**

Fairly common winter visitor in considerable numbers. Found from seaside gardens to the top of the Western Ghats, between mid-October and mid-April.

317. (1465) **Black-naped Flycatcher**
***Hypothymis azurea* (Boddaert)**

A common, considerably numerous resident of the Western Ghats, and a common visitor, in all seasons, to semi-evergreen woods in the coastal and midland regions. Breeding in May-June.

318. (1498) **Streaked Fantail Warbler**
***Cisticola juncidis* (Rafinesque)**

A seasonally and locally common resident in considerable numbers, occurring mainly in the coastal belt and river basins, occasionally at the foot of the Ghats. Closely linked to the two paddy-growing seasons (rain-fed: June to October, irrigated: December to March); uncommon during the remaining months. Breeding in June.

319. (1503) **Ashy-grey Wren Warbler**
***Prinia hodgsonii* Blyth**

A fairly common resident in large numbers, from seaside villages to the foothills of the Western Ghats. Breeding in September.

320. (1511) **Plain Wren Warbler**
***P. subflava* (Gmelin)**

Not uncommon, patchily distributed resident in moderate numbers. Occurs in a wide range of habitats, from seaside creeks to cultivation at the base of the Sahyadris. Breeding in November.

321. (1517) **Ashy Wren Warbler**
***P. socialis* Sykes**

A capriciously distributed resident; common and numerous in its preferred habitat of mangroves and sea-holly. Smaller numbers are found in the most diverse places, from beach creepers just above the high water line to the outskirts of villages at the foot of the Ghats.

322. (1538) **Tailor Bird**
***Orthotomus sutorius* (Pennant)**

Very common, numerous, ubiquitous resident from coast to Ghats (on the base only). Breeds during the SW monsoon.

323. (1549) **Thick-billed Warbler**
***Acrocephalus aedon* (Pallas)**

Rather scarce winter visitor, in small numbers, to the coastal belt, from mid-November to mid-April.

324. (1550) **Indian Great Reed Warbler**
***A. stentorius* (Hemprich & Ehrenberg)**

A not uncommon, moderately numerous winter visitor to the coast, where it favours creeks and saltpans, and rarely to freshwater bodies of the midlands. Arrives in mid-November and has left by mid-March.

325. (1556) **Blyth's Reed Warbler**
***A. dumetorum* Blyth**

A very common winter visitor in very large numbers. Occurs from seaside gardens to the densest wet evergreen forests on the slopes of the Sahyadris, from end-October to mid-April.

326. (1557) **Paddyfield Warbler**
***A. agricola* (Jerdon)**

Numerous and, in the appropriate habitat, common winter visitor between mid-October and mid-April. Found in the coastal belt and river basins.

327. (1562) **Booted Warbler**
***Hippolais caligata* (Lichtenstein)**

Straggler. There are 5 records, between late Oct. and end Dec., from the base of the Ghats and semi-evergreen woodlands of the coastal belt.

328. (1567) **Lesser White-throat**
***Sylvia curruca* (Linn.)**

Stray. Rane (1982) noted this bird at the Bondla WS, in April 1982. I have seen it once, in late Oct. 1985, in a remnant pocket of semi-evergreen forest at the foot of a plateau near the sea.

329. (1574) **Chiffchaff**
***Phylloscopus collybita* (Vieillot)**

Straggler. Up to a dozen birds were recorded on 5 dates (October to March) in the Western Ghats and remnant forest patches on plateau-scarps facing the coastal strip.

330. (1578) **Tytler's Leaf Warbler**
***P. tytleri* Brooks**

Grubh and Ali (1975) collected a specimen in the Cotigao WS, in Nov.-Dec. 1972, the identification of which was disputed by Price (1979). I believe I have seen very small numbers of this confusing leaf warbler twice in the winter of 1985-86, in the Ghats and the coastal belt.

331. (1581) **Olivaceous Leaf Warbler**
***P. griseolus* Blyth**

A specimen was collected by Grubh and Ali (1975) in the BMWS, in November-December 1972. I am quite sure of having had 5 sightings in the same area, between November and February.

332. (1601) **Large-billed Leaf Warbler**
***P. magnirostris* Blyth**

Scarce winter visitor, in moderate numbers, to the Western Ghats and their outlying hills. Roving groups of up to a dozen birds are seen irregularly from early November to late March.

333. (1605) **Greenish Leaf Warbler**
***P. trochiloides* (Sundevall)**

Very common winter visitor, found in very large numbers in all wooded localities, from immediately behind the seashore to the top of the Sahyadris. Between mid-September and mid-April, it is probably Goa's most common bird.

334. (1606) **Large Crowned Leaf Warbler**
***P. occipitalis* (Blyth)**

Not uncommon, moderately numerous winter visitor to the Western Ghats, especially the higher slopes and the crest, between October and mid-March. During passage, in November, it is considerably numerous, found even in remnant forest-patches on plateau-scarps bordering the coastal strip.

335. (1644) **Bluethroat**
***Erithacus svecicus* (Linn.)**

Uncommon, slightly irregular winter visitor in small numbers. Occurs in the coastal belt and river basins from early November to mid-February.

336. (1650) **Blue Chat**
***E. brunneus* (Hodgson)**

Writing about the adjoining N. Kanara dist., Karnataka, Davidson (1898) found this bird 'a rare straggler to the line of the Ghats'. In November-December 1994, P.J. Willoughby (1996), a visiting British birder, observed a male in the Bondla WS, while I have two records of males from the top of the Dudhsagar waterfalls in the BMWS, in April and December.

337. (1661) **Magpie Robin**
***Copsychus saularis* (Linn.)**

A common and plentiful resident from the coast to the Ghats. Breeding in May-June.

338. (1665) **Shama *C. malabaricus* (Scopoli)**

A not uncommon, moderately numerous resident of the lower reaches (up to *ca* 150 m) and the crest of the Ghats. An attempt by this species to expand into valleys and gullies on the scarp of plateaus bordering the coastal belt, during 1984 to 1986, was apparently abandoned in the following years.

339. (1671) **Black Redstart**
***Phoenicurus ochruros* (Gmelin)**

Scarce and irregular winter visitor, in very small numbers, to the coastal region. Grubh and Ali (1975) noted one at the base of the Ghats.

340. (1697) **Stone Chat**
***Saxicola torquata* (Linn.)**

Not uncommon winter visitor. Being partial to saline and brackish fallow lands, this bird is found in the coastal belt, river basins and, occasionally, on barren plateaus not more than 20 km from the sea. Present in very moderate numbers (except in 'invasion years' like 1996 and during passage, when numbers rise considerably) from late September to mid-March.

341. (1700) **Pied Bush Chat *S. caprata* (Linn.)**

A common, considerably numerous, monsoon fugitive and local migrant. Found in the coastal belt and margins of plateaus bordering cultivation. Departs in the first week of June, just a few days ahead of the onset of the monsoon, and returns in mid-September.

342. (1706) **Isabelline Chat**
***Oenanthe isabellina* (Temminck)**

Vagrant. There are four sightings of up to 5 birds on a barren lateritic plateau near the coast, at Sancoale (Marmagoa), in November-December of three consecutive years in the mid-eighties.

343. (1720) **Indian Robin**
***Saxicoloides fulicata* (Linn.)**

Common resident, in considerable numbers, of the midland plateaus and valleys on their scarps.

344. (1723) **Blue-headed Rock Thrush *Monticola cinclorhynchus* (Vigors)**

Rather uncommon winter visitor in small numbers. Occurs at all elevations in the Western Ghats and their outlying hills, occasionally also in gullies on the scarp of midland plateaus. Arrives before 10th November, and departs in early April.

345. (1726) **Blue Rock Thrush *M. solitarius* (Linn.)**

A not uncommon winter visitor in moderate numbers, found on offshore islets, steep rocky seashore, headlands and cliffs on the scarp of the Sahyadris, from early October to early April. Davidson (1898) saw one on 4th May (!!) 1893, at Marmagoa harbour.

346. (1728) **Malabar Whistling Thrush *M. horsfieldii* (Vigors)**

The 'idle schoolboy' is a common, considerably numerous resident of the Western Ghats and, to a slightly lesser degree, their foothills. During the rains, the breeding season, it is the most common bird at altitudes of 100 to 500 m. In the non-breeding season, it is occasionally found in well-wooded valleys of the plateau zone. For several years, a pair used to overwinter at the confluence of a perennial stream and the backwaters behind Velsao (Marmagoa) beach, hardly 150 m from the sea.

347. (1733) **Orange-headed Ground Thrush *Zoothera citrina* (Latham)**

The white-throated subspecies *Z. c. cyanotus* (Jardine and Selby) is a common and considerably numerous year-round resident and a summer visitor in large numbers. Occurs in the plateau zone and the Western Ghats at all elevations. The resident population is augmented in end-March by large numbers of migrants that depart again by mid-September Breeding from June to August.

348. (1752) **Blackbird *Turdus merula* Linn.**

Status unclear, probably resident (though records from July to September are lacking) of the midland plateau region and the lower reaches and crest of the Western Ghats. Locally common, in moderate numbers. The irregularity of local occurrences and the confusing array of subspecies and intergrades, as far as they are identifiable in the field, suggest that many of them pass through Goa only on migration.

349. (1794) **Grey Tit *Parus major* Linn.**

Stray. Rane (1982) noted it at the Bondla WS, in April-June 1982. I sighted a group of three in my garden, at Anjuna (Bardez), in May 1988.

350. (1809) **Yellow-cheeked Tit *P. xanthogenys* Vigors**

A not uncommon, moderately numerous resident of the midland region. Roving bands of up to 10 birds are liable to turn up in any wooded locality, except in wet evergreen forest.

351. (1830) **Chestnut-bellied Nuthatch *Sitta castanea* Lesson**

Stray. Noted by Rane (1982) between April and June 1982, in the BMWS. This species is known to occur in the almost adjacent Dandeli WS of N. Kanara, Karnataka.

352. (1838) **Velvet-fronted Nuthatch *S. frontalis* Swainson**

Fairly common, considerably numerous resident of the lower slopes of the Sahyadris and the outlying clusters of hills; more common during the monsoon.

353. (1852) **Indian Tree Pipit *Anthus hodgsoni* Richmond**

Grubh and Ali (1975) collected a specimen in the BMWS, in November-December 1972. I have identified this bird with certainty only once, in January 1985, in the same sanctuary.

354. (1854) **Tree Pipit *A. trivialis* (Linn.)**

A not uncommon winter visitor, in considerable to large numbers, to coastal lowlands and grasslands on the base and ridge of the Ghats. Arrival in early November, departure before March 10.

355. (1858) **Paddyfield Pipit *A. novaeseelandiae* Gmelin**

Uncommon resident and common winter visitor. The small resident population, possibly only oversummering non-breeding birds, is

found in the coastal region, where it seems to have a penchant for the belt of beach creepers immediately behind the high tide line. Large numbers of winter visitors arrive in two distinct thrusts (usually in early September and again at the beginning of October) and occupy all three zones up to the base of the Ghats. The more diffuse outward movement lasts through April into May.

356. (1861) **Tawny Pipit**
***A. campestris* (Linn.)**

Rare winter visitor in very small numbers. The 5 records, of up to 11 birds in a group, from coastal headlands date from Nov. and Feb.

357. (1864) **Red-throated Pipit**
***A. cervinus* (Pallas)**

Vagrant. Frost and Manville (*pers. comm.*) observed a single male in full spring pre-breeding plumage, on fallow pastures at Candolim (Bardez), a coastal village of North Goa, in early March 1997.

358. (1874) **Forest Wagtail**
***Motacilla indica* Gmelin**

This uncommon, moderately numerous winter visitor occurs mainly in the moist deciduous forests at the base and in sholas on the crest of the Sahyadris, avoiding the wet evergreen forest of the scarp. It arrives in mid-October (when one was sighted in a patch of remnant semi-evergreen woods hardly 2 km from the seashore) and leaves by end-March.

359. (1876) **Yellow Wagtail *M. flava* Linn.**

Common winter visitor in considerable to large numbers. Found from beaches to the foot of the Western Ghats, from mid-Nov. to late March.

360. (1883) **Yellow-headed Wagtail**
***M. citreola* Pallas**

Rather scarce, but regular winter visitor to the coastal belt, rarely to the foot of the Ghats. Small to moderate numbers are present from late Nov. onwards; flocks of >500 birds seen in some years, before departure in end-March.

361. (1884) **Grey Wagtail**
***M. cinerea* Tunstall**

Common, moderately numerous winter visitor to all zones, from late Sept. to mid-April

362. (1885) **White Wagtail *M. alba* Linn.**

Scarce but regular winter visitor, in moderate numbers, to all three zones from mid-October to mid-Mar. Has a penchant for irrigated rice-paddies at the foot of the Ghats.

363. (1891) **Large Pied Wagtail**
***M. maderaspatensis* Gmelin**

Common, considerably numerous resident from just behind the seashore to the base of the Sahyadris.

364. (1892) **Thick-billed Flowerpecker**
***Dicaeum agile* (Tickell)**

Uncommon, dry season visitor in moderate numbers; from the coastal belt (rare) to the slopes of the Ghats. Absent from mid-May to early Nov. Breeding in March at *ca* 300 m, in the Ghats.

365. (1899) **Tickell's Flowerpecker**
***D. erythrorhynchos* (Latham)**

Rather uncommon, moderately numerous resident, from the coastal belt to the foot of the Western Ghats. Numbers drop sharply during monsoon.

366. (1902) **Plain-coloured Flowerpecker**
***D. concolor* Jerdon**

Common, very numerous resident of the midland and Ghats; rarely advances into the coastal belt. Breeding in May and October.

367. (1907) **Purple-rumped Sunbird**
***N. zeylonica* (Linn.)**

Very common, ubiquitous resident in very large, wildly fluctuating numbers. Found from the immediate hinterland of the seashore to the base of the Sahyadris. Breeding from Jul. to Oct.

368. (1909) **Small Sunbird**
***N. minima* (Sykes)**

Common, very numerous resident from gardens in seaside villages to the ridge of the Ghats. For most of the year, this is the most common and numerous bird in the forests of the Western Ghats. Numbers drop sharply in the monsoon. Breeding was noted in Feb.-March.

369. (1911) **Loten's Sunbird**
***N. lotenia* (Linn.)**

Rather uncommon resident, in moderate to considerable numbers. Occurs in the midland

region and on the lower reaches of the Ghats. Breeding in February-March.

370. (1917) **Purple Sunbird**
***N. asiatica* (Latham)**

A common, considerably numerous resident of the plateaus and Western Ghats; rarely found in the coastal lowlands. Breeding in Nov.

371. (1927) **Yellow-backed Sunbird**
***Aethopyga siparaja* (Raffles)**

Not uncommon resident, in moderate to considerable numbers, fluctuating with the seasons. Occurs exclusively in gardens and orchards of the coastal region and in the remnant semi-evergreen woods on the scarp of plateaus facing the coastal strip. Davidson (1898) found it 'very rare in Kanara' and thought himself lucky to have seen 'a specimen from the train below Castle Rock' (on the ridge of the Ghats, at the Goa border). Incidentally, this and a recent sighting at Surla (Sattari), also on the ridge, are the only records outside the coastal strip.

372. (1931) **Little Spiderhunter**
***Arachnothera longirostris* (Latham)**

An uncommon, moderately numerous resident of the Western Ghats, encountered mostly in dense evergreen and semi-evergreen forest at 100-200 m.

373. (1933) **White-eye**
***Zosterops palpebrosa* (Temminck)**

Apparently common enough in adjacent N. Kanara above the Ghats, strays rarely into Goa. I have only a handful of records from the border areas along the ridge of the Ghats. Rane (1982), however, sighted it at the Bondla WS, a cluster of high foothills separated by several km from the main Sahyadris.

374. (1938) **House Sparrow**
***Passer domesticus* (Linn.)**

Common resident, in large numbers, of towns and villages. This species began to colonise coastal villages only around 1985. Breeds practically throughout the year.

375. (1949) **Yellow-throated Sparrow**
***Petronia xanthocollis* (Burton)**

Common, dry season, breeding visitor, in large numbers, to all zones up to the foothills of the Western Ghats where it is numerous in moist deciduous forests (with night roosts of over 1000 birds). Breeding December to May. Absent between late May and mid-October.

376. (1957) **Baya *Ploceus philippinus* (Linn.)**

Resident from coastal lowlands to the foot of the Sahyadris. Uncommon in the dry season from mid-November to late March when Bayas breed around irrigated winter paddy; common, very numerous during the monsoon, when they nest near the much more extensive rain-fed kharif crop.

377. (1968) **White-backed Munia**
***Lonchura striata* (Linn.)**

Common, resident in large numbers. Spread almost evenly from the coastal strip to the lower slopes of the Ghats. Breeding Feb. to Sep.

378. (1973) **Rufous-bellied Munia**
***L. kelaarti* (Jerdon)**

Stray. Up to 5 birds of the subspecies *L. k. jerdoni* (Hume) were sighted on three occasions on the higher scarps of the Western Ghats where the railway line leads up to Castle Rock (N. Kanara, Karnataka).

379. (1974) **Spotted Munia**
***L. punctulata* (Linn.)**

Scarce visitor, in flocks of up to 20 birds, to coastal lowlands, from February to June.

380. (1978) **Black-headed Munia**
***L. malacca* (Linn.)**

Scarce, irregular visitor, in very small numbers, to coastal lowlands and foothills of the Ghats (once). Recorded between late August and end-October.

381. (2013) **Common Rosefinch**
***Carpodacus erythrinus* (Pallas)**

Uncommon, irregular, winter visitor in moderate numbers. Found mainly in the foothills of the Western Ghats, to a lesser degree in the plateau zone, from early December to early April.

382. (2043) **Black-headed Bunting**
***Emberiza melanocephala* Scopoli**

Sporadic winter visitor, in singles and pairs, to grasslands at the foot of the Ghats, scrubby plateaus and coastal headlands.

Appendix

Unconfirmed records of birds that are difficult to identify in the field and of records within 5 km beyond Goa's borders:

1. (11) Audubon's Shearwater *Procellaria lherminieri* (Lesson)

I had a sighting of one bird off the coast at Anjuna (Bardez), in mid-June 1984, after severe cyclonic squalls.

2. (31) Lesser Frigate Bird *Fregata minor* (Gmelin)

In mid-September 1990, I saw a female over Anjuna Beach (Bardez).

3. (332) Banded Crake *Rallina eurizonoides* (Lafresnaye)

Davidson (1898) '...noticed this bird in the neighbourhood of Karwar ... I obtained a single specimen however at Sadasheogarh, which took refuge in the bungalow there on 6th June, 1894, during a severe thunderstorm.'

4. (410) Jack Snipe *Gallinago minima* (Brunnich)

I flushed a single from an irrigation ditch near the base of Dudhsagar waterfalls in BMWS, in Mar. 1988.

5. (581) Small Cuckoo *Cuculus poliocephalus* Latham

In November 1988, I saw a single bird at Kalay (Sanguem), at the base of an outlying hillock of the Western Ghats.

6. (598) Sirkeer Cuckoo *Taccocua leschenaultii* Lesson

'This is a very rare bird in Kanara. Aitken obtained a specimen north of Karwar...' (Davidson 1898).

7. (627) Eagle Owl *Bubo bubo* (Linn.)

'A pair are generally to be found at the side of the hill at Sadasheogarh, north of Karwar.' (Davidson 1898).

8. (1521) Jungle Wren Warbler *Prinia sylvatica* Jerdon

I observed a single bird in a fragment of semi-evergreen forest on a plateau scarp facing the coastal strip, at Arpora (Bardez), in December 1995.

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OIL BAIT FISHERY OF CATFISHES IN BRAHMAPUTRA RIVER AFFECTING RIVER DOLPHIN POPULATIONS IN ASSAM, INDIA[1]

S.P. Bairagi[2]

Keywords: *Platanista gangetica*, dolphin oil, bait fishery, gillnets, Binn, gharuwa fishing, Brahmaputra

Threats to the Ganges river dolphin (*Platanista gangetica*) in River Brahmaputra were studied. Dolphin oil bait fishery (locally called as gharuwa fishing) was determined to be the major threat to this animal. 'Binn' – the migrant community from the neighbouring state Bihar, are the only trappers of river dolphins. Dolphin oil is used as a strong lure to catch catfishes in the Brahmaputra. It is mixed with an equal quantity of rape seed oil and applied on roasted sheep guts to prepare the bait. *Clupisoma garua*, *Eutropicthys vacha* are the catfish species caught by this type of fishing. A boat composed of 3 fishermen, 'Gharuwa' fishing unit, can fish up to 20-25 kg of fishes per night with 1-1.5 litres of oil. Dolphins were killed either with harpoons or under water gillnets. 20-25 litres of oil is obtainable from a moderately sized dolphin. Dhubri and Goalpara are the two main areas where this business is prevalent. A substitute for dolphin oil, a fish oil (waste product of fish based industries) from coastal India was tested with success as an alternative.

Introduction

A highly threatened aquatic mammal, the Ganges river dolphin (*Platanista gangetica*) has a discontinuous distribution, being found only in a few small pockets of the Indian subcontinent – in River Ganges, Brahmaputra, Meghna and Karnaphuli and their major tributaries. The river dolphin population is under multiple threats throughout its range of distribution due to large scale poaching and habitat loss. The population in Ganges is about to be wiped out mainly due to habitat degradation. During the last 5 years, the population in River Brahmaputra, once the safest place for river dolphins, has also declined drastically due to large scale poaching.

From a study on the status and threats to the river dolphins (Bairagi *et al.* 1993), it is known that the main causes of depletion are the loss of habitat and now, more importantly, commercial exploitation of the animal in the Brahmaputra river. Construction of dams and barrages along its major tributaries has isolated the population into some small pockets which gradually disappear. The exact mortality rate is not known, as the river systems are vast and remote. Moreover, for this type of work, extensive monitoring of the river system involving huge fund allocation is required.

The commercial exploitation of river dolphins in the Brahmaputra and Ganges is mainly for the oil from its blubber, which accounts for about 30% of its total body weight. This fat is used for medicinal purposes (aphrodisiacs) and, more importantly, as an effective fish lure.

Some catfishes (*Clupisoma garua* and *Eutropicthys vacha*) are fished with the help of strong smelling dolphin oil bait, which attracts them. These fishes have a moderate market value, but large numbers of fishes can be caught by this method, therefore, large amounts of dolphin oil are used. A great demand for dolphin oil in these areas has resulted in indiscriminate killing of the dolphins. Serious measures will have to be taken immediately if the river dolphins of Brahmaputra are to be saved from extinction.

Material and Methods

This paper describes a study undertaken in 1993-94, in the Brahmaputra river system.

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Information about the dolphin oil bait fishery and killing of river dolphins was collected from the fishermen along the river bank. Killing methods at all concerned places were studied. Fishermen communities practising oil bait fishery were identified. Various methods applied for the extraction of oil were studied. Spot surveys were carried out along the river to locate the important places of fishing. Businessmen involved in the sale of dolphin oil were interviewed.

The procedure and effectiveness of dolphin oil as bait was studied by conducting surveys with a fishery worker for on-the-spot verification. A substitute for dolphin oil, crude fish oil, was introduced to test its suitability. A known quantity of fish oil was given to the fishermen. The fish catch data collected was later compared with the dolphin oil fish catch. Market feasibility was studied to commercialise the fish oil in the local markets of the areas.

Procedure of dolphin oil bait fishing: This nocturnal fishing method varies from place to place. Three fishermen and a boat constitute a Gharuwa fishing unit. One of them is engaged solely in the preparation of the bait. Roasted sheep gut is chopped into small pieces and mixed with charcoal. This helps the material to float. Equal quantities of rape seed oil and dolphin oil are then mixed with the chopped gut. A small quantity of this bait is spread over the water. Within a few seconds, catfishes attracted by the strong smell accumulate near the boat, and are caught with "hook and line" using the same material in the hook as bait. In some places, dolphin oil is applied on big pieces of roasted duck meat.

Results and Discussion

Reliable information on the killing of dolphins in Brahmaputra river was obtainable from fishermen not involved in this practice. There are two methods of killing river dolphins, harpoons or by gill nets. Surfacing dolphins are struck with a harpoon having a long rope tied to retrieve it. The nets are generally made of strong monofilament nylon and placed in the migrating routes of the dolphins. As the material is very fine, the dolphins' echolocating mechanism cannot detect the net; they get trapped and die of suffocation.

At times, dolphins are accidentally caught in the gill nets meant to catch fish and die. These dolphins are sold to dolphin oil bait fishermen. This is an indirect mode of killing.

Binns, a local community that migrated from the neighbouring state of Bihar, are the main trappers of river dolphins and are exclusively involved in dolphin oil bait fishery. They are locally called Gharuwa fishermen and the method of fishing is called Gharuwa fishing. In the Brahmaputra, about 500 fishermen use this method of fishing throughout the river stretch. Some of them are involved exclusively in killing of dolphins and supply of dolphin oil.

To extract oil, the dolphin is first cut into small pieces and kept in tin containers (15 kg capacity). These containers are secretly buried under sand at the river bank in remote areas. After a few days, the oil separates out of the flesh. 7-8 litres of oil is obtained from a container of flesh and fat. Depending on the size of the animal, each dolphin requires 3 to 4 containers.

Throughout the length of River Brahmaputra in northeast India, there are 2 major and 3 minor sites where this business is prevalent. The major sites are Dhubri and Goalpara located on the lower stretch of the river. The Binn community resides here and conducts dolphin oil bait fishing throughout the Brahmaputra. The 3 minor sites are Chandrapur, Tezpur and Dibrugarh on the lower, middle and upper stretch of Brahmaputra respectively.

The businessmen involved in dolphin oil sale do it on the side, as this type of fishing is practised only in the lean seasons i.e., when water becomes clear and its level goes down. A container of dolphin flesh and fat costs about Rs. 300-400 from which 7 to 8 litres of oil (at Rs. 40-45 per litre) can be extracted.

Depending on the availability of fishes, a boat can fish up to 20 kg per night. 1 to 1.5 litres of oil are required by a boat per night. From a moderate sized dolphin, only 20 to 25 litres of oil is extracted. In Dhubri and Goalpara, there are about 100 fishing boats engaged in Gharuwa fishing. Hence, the chance of indiscriminate killing of the animal in these areas is very high.

Fish oil was tested as a substitute, to save the river dolphins of Brahmaputra. This fish oil was brought from the coast as a sample and introduced here. It was found that fish oil is as effective as dolphin oil, as the same quantity of fish can be caught using this oil. The fishermen are also happy with this new oil. If the required quantity of fish oil can be supplied at the same price as dolphin oil, the fishermen will stop killing the dolphins. This alternative must be considered for the conservation of the threatened river dolphins of the Brahmaputra.

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■ ■ ■

CARIDINA TYPUS H. MILNE EDWARDS 1837 FROM THE INDIAN MAINLAND — A REPORT[1]

Delphin Ebenezer[2] and Jasmine Richard[3]

(*With four text-figures*)

Key words: *Caridina typus,* Crustacea, Atyidae, Appendix masculina, Appendix interna

Freshwater prawns of the family Atyidae enjoy wide distribution in India. Nearly a century ago, Henderson (1893) first recorded the occurrence of an atyid prawn from India, of the genus *Caridina*, which he identified as *C. wyckii* (Hickson), from Chennai. In subsequent years, several carcinologists contributed towards the taxonomy of the Atyidae of India. Yet, the type species of the genus *Caridina* viz. *Caridina typus.* H. Milne Edwards 1837, though widely distributed in the Indo-Pacific area, was recorded only from Andaman Islands (Tiwari & Pillai 1971) and not from the Indian mainland. The present note records the occurrence of *C. typus* from four streams in the fringing localities of Kanyakumari district of Tamil Nadu and extends its distribution to the Indian mainland.

Introduction

As part of a research project, the first author surveyed the freshwater bodies of Kanyakumari dist. for the presence of freshwater prawns. Numerous specimens of several species of the atyid genus *Caridina* were collected. *C. typus* was collected for the first time from the Indian mainland, from the streams in Methukammal, Kunchacode, Manavalakurichi and Manakal Odai (Fig. 1). Samples of the collected specimens are deposited in Rijksmuseum Van Natuurlijke Historie Leiden, The Netherlands – Reg No. Crust. D. 46659.

Caridina typus H. Milne Edwards 1837. (Figs. 2-4)

Description

Maximum length of the prawn is 39 mm. Males 14-24 mm; Females 32-39 mm. Rostrum short, reaching the tip of the 2nd segment of the antennular peduncle; upper margin entire; lower margin interrupted with 1-3 teeth.

$$\text{Rostral formula} = \frac{0}{1\text{-}3}$$

Antennal spine is at the lower orbital angle. The pterygostomian angle is rounded. Stylocerite reaches 3/4th of the basal segment of the antennular peduncle.

Carpus of the 1st pereiopod deeply excavated, equal to merus and shorter than chela, 1.38 to 1.5 times as long as its breadth. Carpus of the 2nd pereiopod not deeply excavated, 4.06 to 5.10 times as long as its breadth and longer than merus and chela. Finger longer than palm; propodus of 3rd pereiopod 8.30 to 10.30 times as long as its breadth, 3.98 to 4.0 times the dactylus and bears 5 to 7 spines. Propodus of the 5th pereiopod 13.10 to 14.50 times as long as its breadth, 3.70 to 4.20 times the dactylus. Dactylus 4.03 to 4.50 times its breadth and bears 45 to 60 minute spinules arranged in a comb-like fashion.

Pereiopods 1 to 4 bear epipodites. The first pleopods of the males bear a distinct appendix interna on their endopod. The 2nd male pleopod bears appendix masculina.

Telson bears 5 to 6 pairs of dorsal spines. Its posterior margins bear a median spine and

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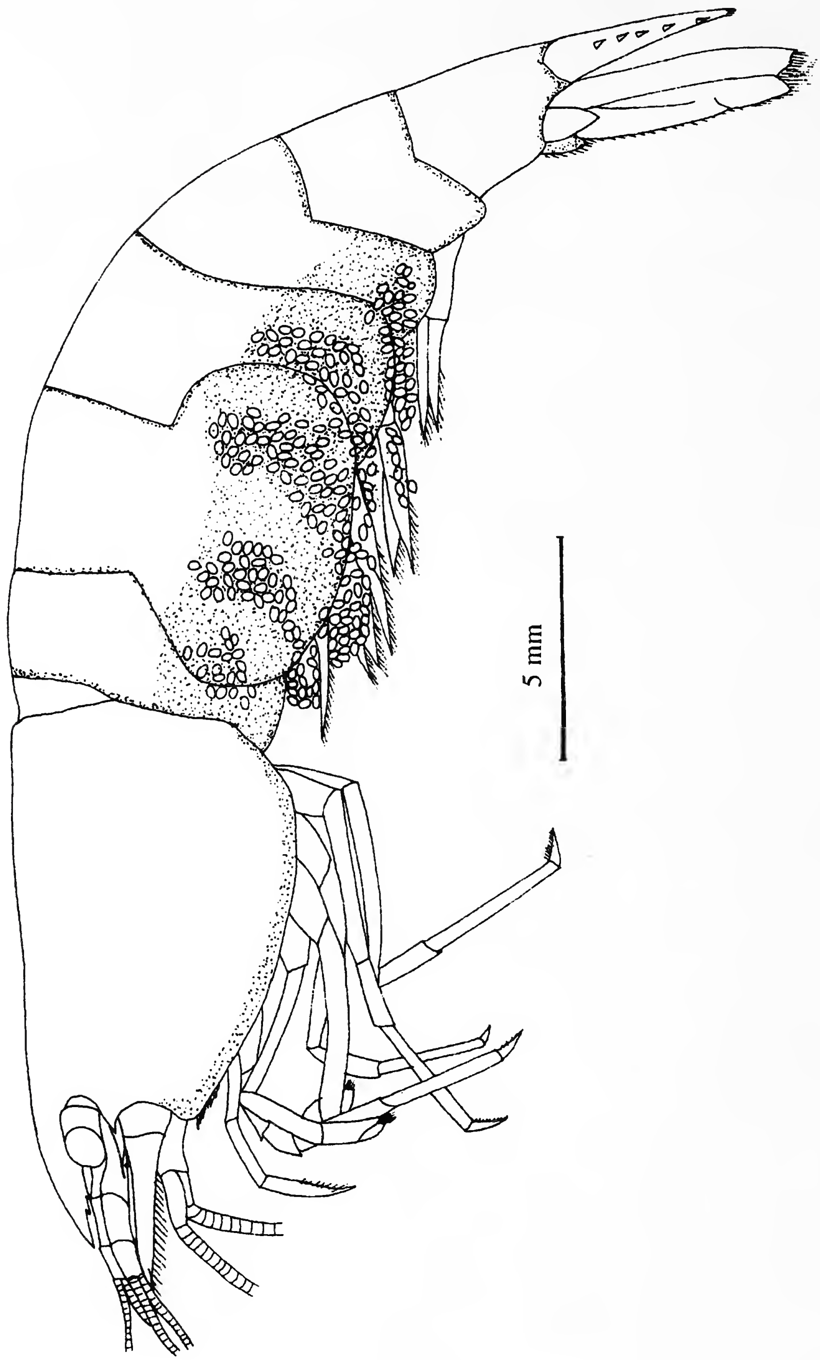

Fig. 1: *Caridina typus* H. Milne Edwards 1837. Lateral view

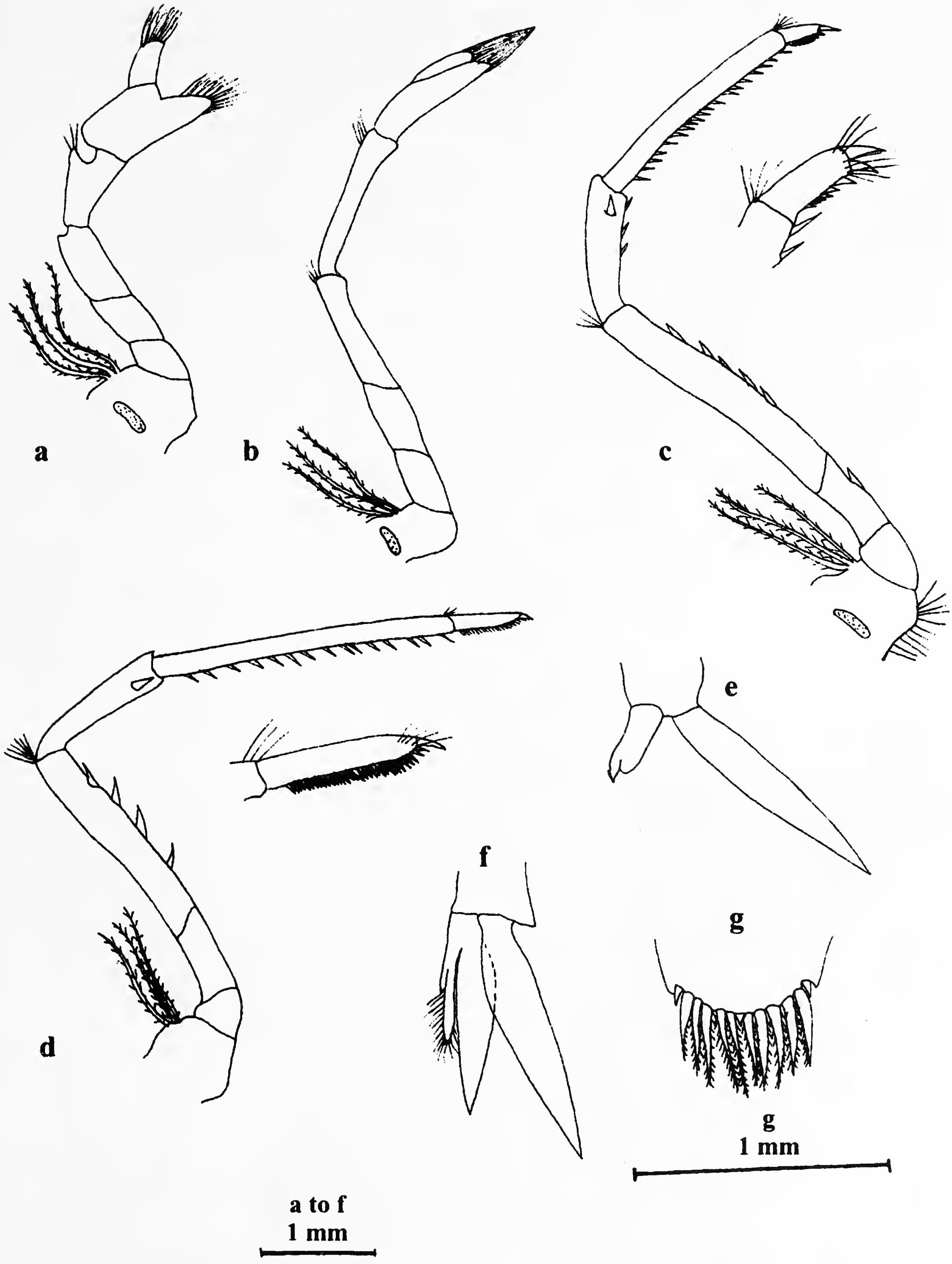

Fig. 2: *Caridina typus* H. Milne Edwards, 1837. a - c: Pereiopods I-III; d. Pereiopod V; e. Pleopod I of male; f. Pleopod II of male; g. Telson.

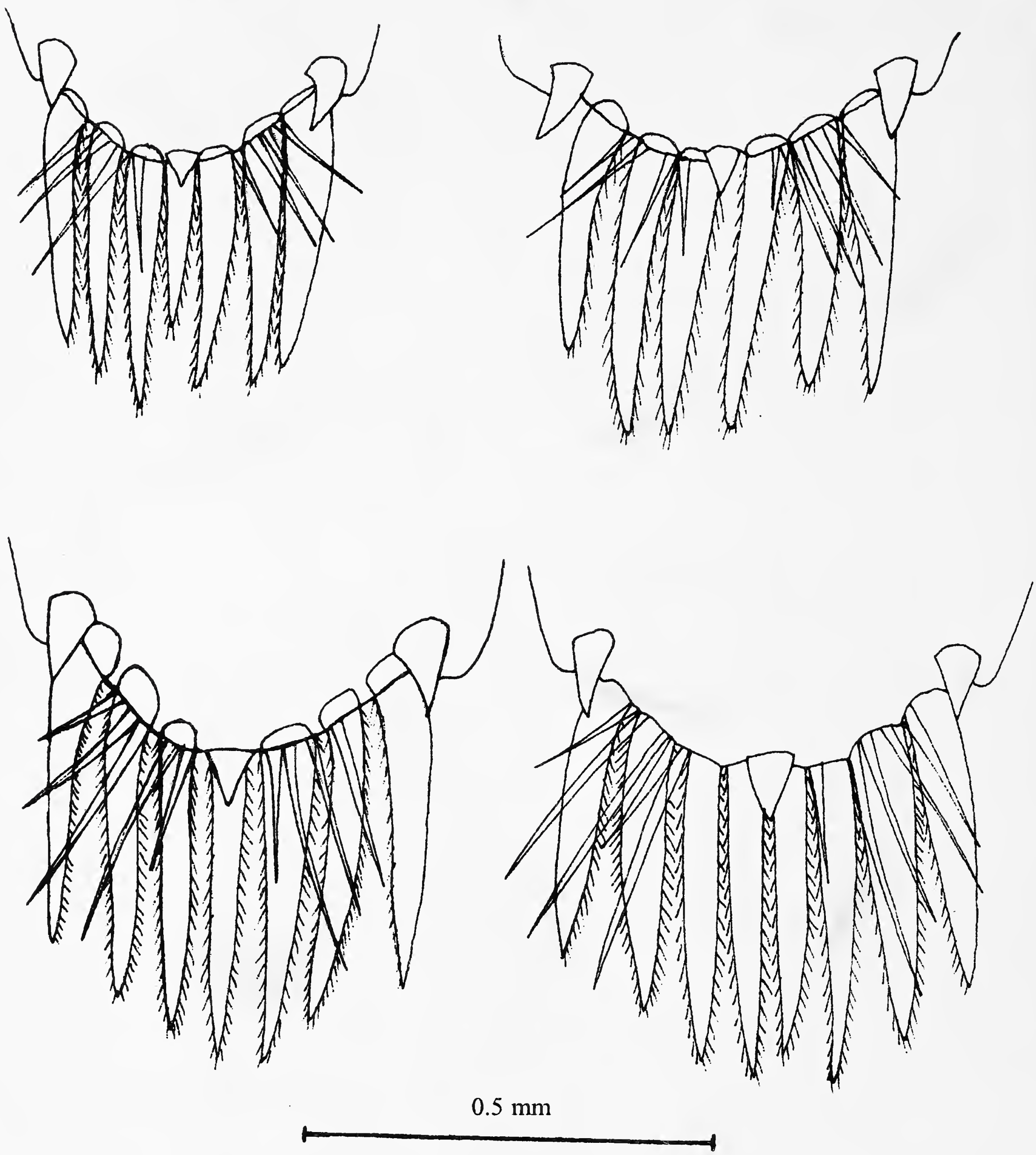

Fig. 3: *Caridina typus* H. Milne Edwards 1837, variations in Telson

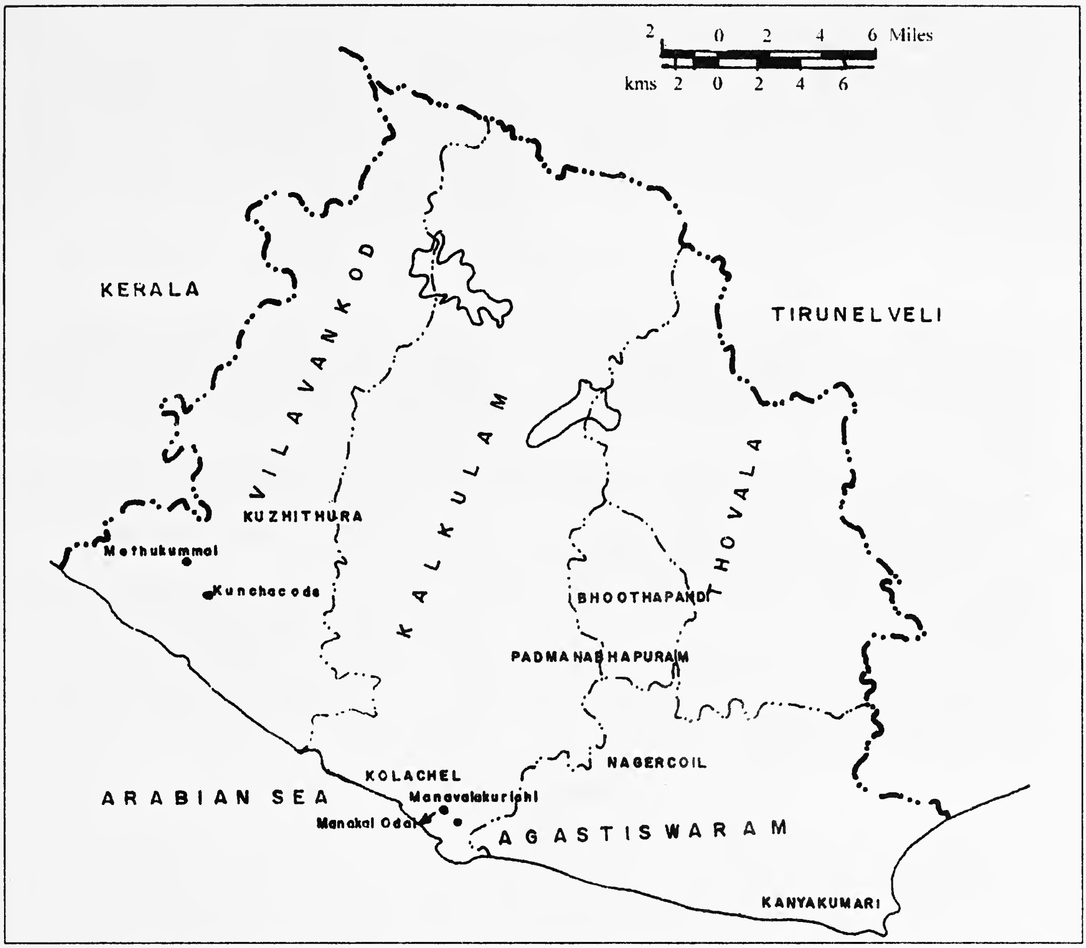

Fig. 4: Map of Kanyakumari district showing locations of occurrence of *Caridina typus*

6 to 10 long spines. The lateral spines are slightly shorter than the median ones which are almost equal in length.

Uropod diaeresis spines are 16 to 21 (mostly 19). Eggs numerous; in one berried female there were 3708. Each egg measures 0.24 to 0.29 mm x 0.42 to 0.47 mm.

Discussion

Caridina typus has a wide distribution in the Indo-west Pacific area, ranging from East Africa to Japan and Polynesia (Holthuis, 1965). Johnson (1960, 1963) dealt with *C. typus* and emphasized the insular distribution of the species, being restricted to a few fringing localities never far from the sea and never in major river systems. Tiwari & Pillai (1971) described *C. typus* from freshwater streams of Andaman Islands. So far, *C. typus* had not been reported from the Indian mainland, even though it was reported from neighbouring Sri Lanka by De Silva (1982) and Benzie & De Silva (1984).

The present report of *C. typus* from the freshwater streams of Kanyakumari dist.

confirms the presence of the species on the Indian mainland for the first time. The pattern of distribution along the shore conforms with the observation of Johnson (1963). The present record of this species along the fringing localities of Kanyakumari dist. may lead to further reports from the Indian subcontinent.

ACKNOWLEDGEMENTS

We thank Prof. L.B. Holthuis for taxonomic consultation and for depositing the specimens in the Rijksmuseum Van Naturrlijke Historie, Leiden, Netherlands. We gratefully remember late Dr. D.R. Jalihal for the constant support given by him.

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POPULATION STATUS AND MALE GENITALIA OF *LETHE EUROPA NILADANA* AND *PARARGE EVERSMANNI CASHMIRENSIS* (LEPIDOPTERA: SATYRIDAE)[1]

H.S. Rose and Narender Sharma[2]

(With ten text-figures)

Key words: *Lethe, Pararge,* Satyridae, population, male genitalia, Wildlife Act.

Male genitalia of two rare subspecies, i.e., *Lethe europa niladana* Fruhstorfer and *Pararge eversmanni cashmirensis* Moore have been studied. The females of both the species could not be collected during recent surveys undertaken between 1992 to 1996. Owing to their rarity and restricted distribution, it is proposed that they may be included in the Wildlife (Protection) Act, 1972.

Introduction

Under two ICAR sponsored projects, we studied fifty-four Satyrid species from northwest India. Out of these, two species have been identified as *Lethe europa niladana* Fruhstorfer and *Pararge eversmanni cashmirensis* Moore on the basis of one male specimen each. Like most other Indian butterfly species, the external genitalia of these two had not been studied so far. Accordingly, an illustrated account of the male genitalia is provided. Their status has also been reviewed in the light of the Wildlife (Protection) Act, 1972.

Observations

Bamboo treebrown *Lethe europa* (Fabricius)

Fabricius, 1775, Syst. Ent.: 500 (*Papilio*).

Lethe europa niladana Fruhstorfer

Fruhstorfer, 1911, Fauna Indo-Austral 9:315 (*Lethe*)

Male genitalia (Figs. 1-5): Uncus longer than tegumen, curved ventrally, broad at base, beak-like, with distal end rounded, setae absent; brachia wanting; tegumen somewhat oval, narrow ventrally; appendices angulares long, blunt distally, slightly curved inwardly, broad at base; vinculum longer than tegumen, thin strip-like; saccus moderately long, broad proximally, distal end rounded; valva with proximal half boat-shaped, distal half narrow, distal end slightly swollen, pilose; juxta U-shaped, strongly sclerotised; aedeagus long, tubular, subzone and suprazone almost equal in length, ductus ejaculatorius entering dorsad.

Female genitalia: Not examined.

Length of Forewing: Male: 32.0 mm.

Material examined: Uttar Pradesh: 1♂, 26.vi.1992, Bhimtal, Nainital.

The species *europa* Fabricius is the type-species of the genus *Lethe* Hübner and is represented by twelve subspecies. Out of these, *europa niladana* (Northern India to Burma), *europa nudgara* Fruhstorfer (Andaman Islands) *europa tamuna* de Niceville (Nicobar Islands) and *europa ragalva* Fruhstorfer (Southern India) belong to India (D'Abrera, 1985). The former subspecies, whose range has been given from Kumaon to Burma by Bingham (1905) has been dealt with here. According to Talbot (1947), the range of this subspecies extends from the erstwhile Punjab to Burma, Siam and Tong-King. Relying upon present surveys, the subspecies under reference is apparently very rare in the Kumaon Himalaya now.

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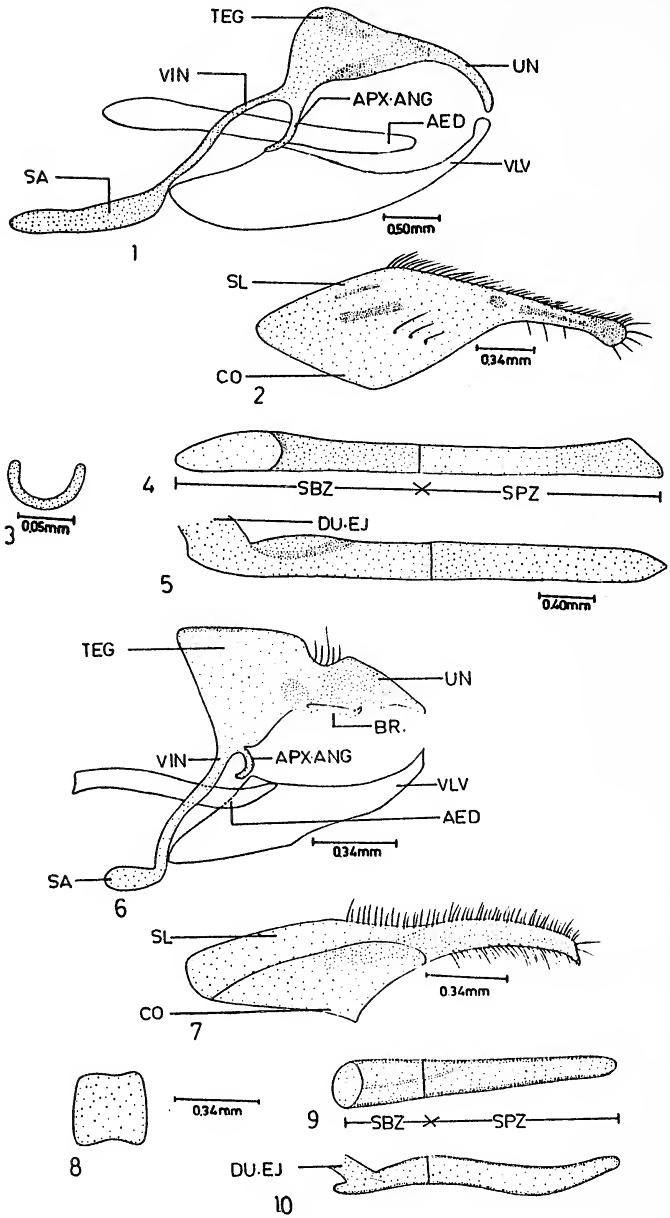

Figs. 1-5. *Lethe europa niladana* Fruhstorfer: 1. Male genitalia (lateral view), 2. Valva (inner view), 3. Juxta, 4. Aedeagus (dorsal view), 5. Aedeagus (lateral view);
Figs. 6-10. *Pararge eversmanni cashmirensis* Moore: 6. Male genitalia (lateral view), 7. Valva (inner view), 8. Juxta, 9. Aedeagus (dorsal view), 10. Aedeagus (lateral view).

Yellow Wall *Pararge eversmanni* Eversmann

Eversmann, 1847, Moscow Bulletin 2: pl. 2 figs 5, 6 (*Pararge*).

Pararge eversmanni cashmirensis Moore

Moore, 1874, Proc. zool. Soc. Lond.: 265, pl. 43 (*Pararage*).

Male genitalia (Figs. 6-10): Uncus shorter than tegumen, broad, narrow distally, beset with a few setae at base dorsally, a deep notch present between tegumen and uncus; brachia very slender, extending half the length of uncus, distal end upturned dorsally; tegumen long, broad; appendices angulares inwardly curved with blunt distal end; vinculum and tegumen subequal; saccus small with rounded distal end; valva roughly triangular, distal end pointed, digitate, pilose; juxta squarish, plate-like; aedeagus small, tubular, subzone smaller than suprazone, ductus ejaculatorius entering dorsal.

Female genitalia: Not examined.

Length of Forewing: Male: 27.0 mm.

Material examined: Himachal Pradesh: 1♂, 21.vii.1992, Pangi, Chamba.

Marshall and de Niceville (1883) while enlisting the above species as *Pararge cashmirensis* Moore has recorded its distribution from Goolmurg [Kashmir] (= Gulmarg) and Pangi, besides stating it to be a rare and very local butterfly. The species is quite different from all other Indian species of this family. There are no ocelli on the dorsal surface of the forewings. Bingham (1905) followed Marshall and de Niceville (1883) but Evans (1932) has clarified that *cashmirensis* Moore is a subspecies of *eversmanni* Eversmann. Talbot (1947) has also mentioned this subspecies to be rare from Chitral to Kashmir.

Remarks: The present surveys (1992-1996) further support that the two species studied are becoming rarer. So much so, that in spite of our best efforts, the females could not be collected and their importance in conservation of a species need hardly be emphasised. It is proposed here that these subspecies be closely monitored from the conservation point of view and included in the Wildlife (Protection) Act, 1972, under an appropriate schedule. It may be mentioned that *Lethe europa tamuna* de Niceville reported from Nicobar Islands is included in Schedule 1 (Part IV) of the Act.

Abbreviations used

AED: Aedeagus, APX.ANG: Appendix angularis, BR: Brachium, CO: Costa, DU.EJ: Ductus ejaculatorius, SA: Saccus, SBZ: Subzonal portion of aedeagus, SL: Sacculus, SPZ: Suprazonal portion of aedeagus, TEG: Tegumen, UN: Uncus, VIN: Vinculum, VLV: Valva.

Acknowledgement

We thank the Indian Council of Agricultural Research, New Delhi, Govt. of India, for financial support.

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A NEW RECORD OF FRESHWATER BAGRID FISH *MYSTUS PULCHER* CHAUDHURI FROM INDIA[1]

KEISHING SELIM[2] AND WAIKHOM VISHWANATH

Key words: *Mystus pulcher*, new record, India.

A freshwater Bagrid fish *Mystus pulcher* Chaudhuri originally known from Myanmar, has been recorded for the first time from India. The species was collected from Chatrickong river in the Indo-Myanmar border, which is one of the watersheds of the Chindwin river system. The species is characterised by two pale whitish brown longitudinal stripes, one above and another below the lateral line. A dark spot on the shoulder, another on the base of the caudal fin. A detailed description of the species is provided.

INTRODUCTION

The genus *Mystus* Scopoli (1777) belongs to the family Bagridae and is distinguished from other genera in the following characters: interneural shield between basal bone of dorsal fin and occipital process absent; anal fin short with 9-16 rays (Jayaram 1981). Talwar and Jhingran (1991) described eighteen species, of which fifteen are distributed in India and the rest in neighbouring countries. Datta and Laishram (1984) mentioned the possibility of *Mystus pulcher* in Chindwin drainage, hence they included the species in the fish zoogeography list, but without a description. Recently we collected 12 specimens in Chatrickong river. This river is formed of two important streams *viz.* Sanalok and Khunukong. Sanalok flows on the eastern side and Khunukong on the western side; both the streams, after flowing for about 100 km, meet at Dha-ado. The river then flows as Chatrickong for about 5 km in an easterly direction into Myanmar and finally joins the Chindwin drainage. The species is reported for the first time from India and is a new record.

Mystus pulcher Chaudhuri

Mystus pulcher Chaudhuri, 1911, *Rec. Indian. Mus.*, 6: 20 pl. 1, fig 4 (type locality: Bhamo, Myanmar). *Mystus (Mystus) pulcher*, Jayaram 1929, *Rec. Indian Mus.* 51: p. 332

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Material examined: MUMF/ 1100/12 55.1-69.9 mm standard length, coll. Keishing Selim, Chatrickong River, 6.vi.1996.

DESCRIPTION

D. i, 7; i, 8; V. i, 5; A. ii, 10; C 17. Body elongate and compressed. Head depressed, occipital twice as long as broad, reaching basal bone of dorsal fin; median longitudinal groove on head not extending to base of occipital process. Mouth terminal, transverse, upper jaw longer and eyes moderate. Barbels four pairs, maxillary barbels extend posteriorly beyond the anal fin origin, outer mandibulars beyond middle of pectoral spine, inner mandibular barbels to pectoral base. Dorsal spine weak and finely serrated; origin much nearer to adipose dorsal origin than to snout tip. Pectoral fin with a strong spine longer than dorsal spine, finely serrated externally and 10-12 denticulations internally. Pelvic fins do not reach anal; their origin opposite last dorsal ray, much nearer to anal origin than to pectoral base. Anal fin origin just below middle of adipose dorsal, nearly equidistant between pelvic fin origin and caudal fin base. Adipose fin long, inserted close behind dorsal fin. Skin smooth, caudal fin forked.

Proportional Measurements (in %): Body depth 26.07-26.26, Head length 28.33-29.47, caudal length 26.64-28.93, predorsal length 39.39-41.31, dorsal fin height 19.29-21.20, pectoral fin length 20.35-21.91, pelvic fin length 13.77-17.62, anal fin height 17.36-19.91,

caudal peduncle length 15.56-16.61, caudal peduncle depth 11.02-12.72 in standard length. Head width 70.81-75.75, head height at occiput 66.48-72.08, eye diameter 19.79-21.08, inter-orbital space 36.36-39.08, snout length 33.50-35.35, mouth width 41.08-42.42 in head length.

Colour: Dark brown above, lighter below; two pale whitish brown longitudinal stripes, one above and the other below the lateral line. A dark spot on shoulder, another on the base of caudal fin.

Distribution: INDIA: Chatrickong River, Ukhrul dist., Manipur; Myanmar.

DISCUSSION

The specimens examined agree with the original description of the species from Myitkyina, Myanmar described by Chaudhuri (1911). Though slight difference is seen in the morphometric measurements, these are small and within the range of *Mystus pulcher*.

The present specimens were collected in June 1996, when the water was quite muddy. The species was usually found in this muddy bottom. This note extends the distribution of *Mystus pulcher* (Chaudhuri 1911) from its original drainage in Myanmar to the Chindwin watershed in Manipur, India and is thus a new record for India.

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COMPARISON OF *MYSTUS PULCHER* CHAUDHURI WITH SPECIMEN FROM CHATRICKONG MANIPUR, INDIA.

Characters	Specimen from Chatrickong, Manipur	*M. pulcher* (Jayaram 1977)	*M. pulcher* (Talwar and Jhingran 1991)
Body depth in SL	3.45-3.79	3.8	3.8
Head length in SL	3.39-3.52	3.0-3.6	-
Eye diameter in HL	4.74-4.82	-	3.8-4.3
Caudal peduncle height in its length	1.6	-	1.8
Branchiostegal rays	6	-	6
Barbels	4	-	4

- not given

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AN UPDATE ON SYNOPTIC CATALOGUE OF LAC INSECTS (HOMOPTERA : TACHARDIIDAE)[1]

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Key words: Homoptera, Tachardiidae, lac insects

Members of the family Tachardiidae (= Kerriidae) produce lac and certain species are exploited for their economically important products *viz.*, resin, dye and wax. An updated checklist of world species is provided. It includes two subfamilies, nine genera and eighty-seven species. The systematic list provides name of species, author, year of description, synonym(s) if any, and country (state/region) of occurrence. Taxa and species are listed in alphabetical order. The bibliography includes citations of each taxa for reference and taxonomic purposes.

Introduction

Lac insects are degenerate scale insects, belonging to the family Tachardiidae and are well known for their commercially important products *viz.* resin, dye and wax. Kerr (1782) was the first to study a species of lac insect in detail and named it *Coccus lacca* which is now known as *Kerria lacca* (Kerr). A separate identity to lac insects was given by Oken (1815) who placed them under genus *Laccifer*. The taxonomic aspects of lac insects, however, remained obscure, till Chamberlin (1923) gave the first description of lac insects of the world which he later supplemented (Chamberlin, 1925). Kapur (1958) prepared a catalogue of lac insects and Varshney (1977) described all the oriental species in detail. Varshney (1990) also published a brief catalogue of lac insects, reporting eight genera and 77 species as well as a world list of lac insects (Varshney, 1993) in which some of the taxa have been mentioned as *nomen nudum*. Later, Zhang (1993) described some more species. The list recently updated by Varshney (1997) contains no bibliographic references to the newly discovered taxa and the species which were earlier described as *nomen nudum*. Moreover, the list is incomplete, Thus, at present, lac insects are represented by two subfamilies, nine genera and eighty-seven species. The updated systematic list given here provides: name of species, author, year of description, synonym(s) if any and country (state/region) of their occurrence in that order. A consolidated list of bibliographic references to all the taxa reported in the checklist has been provided.

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Checklist

Family: **Tachardiidae** Green 1896 [Syn. **Lacciferidae** Cockerell, 1924; **Kerriidae** Lindinger 1937]

Subfamily: **Tachardiinae** (Nominate) [Syn. **Lacciferinae** Chamberlin 1925].

Tribe: **Austrotachardiini** Chamberlin 1925 [Syn. **Austrotachardinina** Balachowsky 1950].

I. ***Austrotachardia*** Chamberlin 1923.
[Type species: *Tachardia angulata* Froggatt].

1. *A. acaciae* (Maskell 1891). Australia (Central Australia and New South Wales).
2. *A. angulata* (Froggatt 1911). Australia (New South Wales).
3. *A. australis* (Froggatt 1899). Australia (Queensland).
4. *A. convexa* (Fuller 1899). Australia (Western Australia).
5. *A. melaleucae* (Maskell 1891). Australia (New South Wales, Victoria and Western Australia).

Tribe **Tachardiini** (Nominate) [Syn. **Lacciferinina** Balachowsky 1950]

Subtribe **Tachardielli** Chamberlin 1925 [Syn. **Tachardiellina** Williams 1969].

II. ***Austrotachardiella*** Chamberlin 1923.
[Type species: *Tachardia rotundata* Cockerell].

6. *A. bodkini* (Newstead 1917). Guyana.
7. *A. cydoniae* (Hempel 1900). [Syn. *Tachardia rosae* Hempel 1900; *Tachardia caerulea* Hempel 1904]. Brazil.
8. *A. gemmiferra* (Cockerell 1893). Jamaica.
9. *A. nigra* (Townsend & Cockerell 1898). Mexico (Vera Cruz and Jalisco).
10. *A. rotundata* (Cockerell 1903). Mexico.
11. *A. rubra* (Hempel 1900). Brazil.
12. *A. trilobata* (Mendes 1936). Brazil.

III. ***Tachardiella*** (Cockerell 1901).
[Type species: *Tachardia cornuta* Cockerell].

13. *T. argentina* (Dominguez 1906). Argentina.
14. *T. artocarpi* (Hempel 1921). Brazil.
15. *T. condaliae* (Leonardi 1911). [Syn. *Tachardia cordaliae* Leonardi 1911]. Argentina.
16. *T. cornuta* (Cockerell 1894). U.S.A. (New Mexico and Texas) and Mexico.
17. *T. ferrisi* Chamberlin 1923. Mexico.
18. *T. fulgens* (Cockerell 1895). U.S.A. (Arizona) and Mexico.
19. *T. glomerella* (Cockerell 1905). [Syn. *T. glomerella* var. *baccharidis* Chamberlin 1923]. U.S.A. (California, New Mexico and Texas).
20. *T. ingae* (Hempel 1900). Brazil.
21. *T. larreae* (Comstock 1882). [Syn. *T. larreae* var. *californica* Chamberlin 1923]. U.S.A. (Arizona, California and Nevada) and Mexico.
22. *T. lycii* (Leonardi 1911). Argentina.
23. *T. mexicana* (Comstock 1882). [Syn. *Tachardia fulvoradiata* Cockerell 1898; *Tachardiella texana* Chamberlin 1923]. U.S.A. (Texas) and Mexico.
24. *T. nigra* Fonseca 1975. Brazil (Sao Paulo).
25. *T. ourinhensis* Hempel 1937. Brazil.
26. *T. parva* (Hempel 1900). Brazil.
27. *T. pustulata* (Cockerell 1895). U.S.A. (Arizona and California).

Subtribe **Tachardii** (Nominate) [Syn. **Lacciferi** Chamberlin 1925].

IV. ***Kerria*** Targioni-Tozzetti 1884.
[Syn. ***Laccifer*** Oken 1815; ***Carteria*** Signoret 1874; ***Tachardia*** Blanchard 1886; ***Lakshadia*** Mahdihassan 1923].
[Type species: *Coccus lacca* Kerr].
i. Subgenus *Kerria* (Nominate).

28. *K. (K.) albizziae* (Green 1911). India (Bihar, Uttar Pradesh and West Bengal) and Sri Lanka.
29. *K. (K.) brancheata* Varshney 1966. India (Bihar).
30. *K. (K.) chamberlini* Varshney 1966. India (Rajasthan).

31a. *K. (K.) chinensis chinensis* (Mahdihassan 1923). [Syn. *Laccifer longispina* Misra 1930; *Laccifer siamensis* Takahashi 1941]. Bhutan, China (South China), Cambodia, India (N.E. India), Myanmar (=Burma), Nepal, Thailand and Vietnam.

31b. *K. (K.) chinensis kydia* (Misra 1930). India (Assam).

32. *K. (K.) communis* (Mahdihassan 1923). India (Andhra Pradesh, Goa, Karnataka, Kerala, Maharashtra and Tamil Nadu).
33. *K. (K.) ebracheata* (Chamberlin 1923). India (Bihar and Karnataka), and Pakistan.

34a. *K. (K.) fici fici* (Green 1903). China, India (Bihar, Delhi, Jammu & Kashmir, Rajasthan, Uttar Pradesh and West Bengal), Pakistan and Thailand.

34b. *K. (K.) fici jhansiensis* (Misra 1930). India (Uttar Pradesh).

35. *K. (K.) indicola* (Kapur 1958). [Syn. *Laccifer indica* Misra 1930]. India (Bihar).

36a. *K. (K.) lacca lacca* (Kerr 1782). [Syns. *Coccus ficus* Fabricius 1787; *Lakshadia indica* Mahdihassan 1923]. Bangladesh, China, Georgia, India, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan and Thailand.

36b. *K. (K.) lacca ambigua* (Misra 1930). India (Uttar Pradesh).

36c. *K. (K.) lacca mysorensis* (Mahdihassan 1923). India (Karnataka).

36d. *K. (K.) lacca takahashii* Varshney 1977. Thailand.

37. *K. (K.) mengdingensis* Zhang 1993. China (Yunnan).
38. *K. (K.) nagoliensis* (Mahdihassan 1923). India (Madhya Pradesh).
39. *K. (K.) nepalensis* Varshney 1977. India (Bihar) and Nepal.
40. *K. (K.) pusana* (Misra 1930). India (Bihar).
41. *K. (K.) ruralis* (Wang, Yao, Teui & Liang 1892). China (Yunnan).
42. *K. (K.) sharda* sp. nov. Mishra and Sushil 2000.
43. *K. (K.) sindica* (Mahdihassan 1923). Pakistan (Sind).
44. *K. (K.) yunnanensis* Ou & Hong 1990. China (Yunnan).

ii. Subgenus *Chamberliniella* Varshney 1987.
[Syn. *Chamberlinia* Varshney 1984].
[Type species: *Tachardia greeni* Chamberlin].

45. *K. (C.) greeni* (Chamberlin 1923). Philippines, Taiwan and Thailand.
46. *K. (C.) javana* (Chamberlin 1925). Indonesia (Java) and Malaysia.
47. *K. (C.) meridionalis* (Chamberlin 1923). Australia (New South Wales and Victoria).
48. *K. (C.) rangoonensis* (Chamberlin 1925). India (Assam) and Myanmar.

V. ***Metatachardia*** Chamberlin 1923.
[Type species: *Tachardia conchiferata* Green].

49. *M. conchiferata* (Green 1922). Sri Lanka.
50. *M. fukienensis* Zhang 1993. China (Fukien).
51. *M. hunanensis* Zhang 1993. China (Hunan).
52. *M. myrica* Tang 1974. China (Chekiang).
53. *M. sinensis* Zhang 1993. China (Changyan-Yunnan).
54. *M. yunnanensis* Zhang 1992. China (Changyan-Yunnan).

Subfamily **Tachardininae** Chamberlin 1925. [Syn. **Tachardini** and **Tachardinina** of Balachowsky 1950; Type genus: *Tachardina* Cockerell 1901].

VI. ***Afrotachardina*** Chamberlin 1923.
[Type species: *Tachardia longisetosa* Newstead].

55. *A. brachysetosa* Chamberlin1923. Uganda.
56. *A. longisetosa* (Newstead 1911). Uganda.

VII. ***Albotachardina*** Zhang 1992a.
[Type species: *Albotachardina yunnanensis* Zhang].

57. *A. sinensis* Zhang 1992a. China (Yunnan).
58. *A. yunnanensis* Zhang 1992a. China (Yunnan).

VIII. ***Paratachardina*** Balachowsky 1950.
[Type species: *Carteria decorella* Maskell].

59. *P. capsella* Wang 1986. China (Yunnan).
60. *P. decorella* (Maskell 1892). Australia (New South Wales and Victoria).

61a. *P. lobata* (Green 1922). [Syn. *Tachardia minuta* Green 1922 (nec Morrison)]. India. (Andhra Pradesh, Karnataka and Tamil Nadu) and Sri Lanka.

61b. *P. lobata* var. *schmidti* (Mahdihassan 1946). India (Karnataka).

61c. *P. lobata* var. *walczuchae* (Mahdihassan 1946). India (Karnataka).

62. *P. minuta* (Morrison 1920). Philippines.
63. *P. mithilae* Varshney 1968. India (Meghalaya).

64. *P. morobensis* sp. nov. New Papua Guinea.
65. *P. silvestrii* (Mahdihassan 1923). India (Karnataka).
66. *P. ternata* (Chamberlin 1923). India (Kerala).
67. *P. theae* (Green & Mann 1907). India (Sikkim and West Bengal) and Taiwan.

IX. ***Tachardina*** (Cockerell 1901).
[Type species: *Tachardia albida* Cockerell].

68. *T. actinella* (Cockerell & King 1901). [Syn. *Tachardina digitata* Munting 1965]. Mozambique (?), South Africa and Zimbabwe.
69a. *T. affluens* (Brain 1920). Saudi Arabia and South Africa.
69b. *T. affluens* var. *coagulata* Hall 1935. South Africa (Transvaal).
69c. *T. affluens* var. *natalensis* Hall 1935. South Africa (Natal).
70. *T. africana* Hall 1935. Mozambique (?), South Africa and Zimbabwe.
71. *T. albida* (Cockerell 1901) South Africa and Zimbabwe.
72. *T. aurantiaca* (Cockerell 1903). Indonesia (Java), Singapore and Thailand. Varshney (1990 and 1993) has cast doubt over its taxonomical placing.
73. *T. bernardi* Balachowsky 1950. 'Central Sahara' [Algeria].
74. *T. brachystegiae* Hall 1935. Zimbabwe.
75. *T. diclipterae* Hall 1935. Zimbabwe.
76. *T. gripha* Munting 1966. South Africa.
77. *T. karroo* (Brain 1920). South Africa (Cape).
78. *T. leredei* Balachowsky 1950. 'Central Sahara' [Algeria].
79. *T. minor* (Brain 1920). South Africa (Cape).
80. *T. oligopora* Munting 1966. South Africa.
81. *T. perplexa* Munting 1973. South Africa.
82. *T. protrudens* Munting 1965. South Africa.
83. *T. psiadiae* Mamet 1953. Madagascar.
84. *T. recurva* Munting 1973. South Africa (Cape).
85. *T. sclerosa* Munting 1965. South Africa.
86. *T. spinosa* Munting 1966. South Africa.
87. *T. tismbazazae* Mamet 1953. Madagascar.

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FERN FLORA ALONG SAUNG-PINDARI TREK IN THE KUMAON HIMALAYA[1]

M.K. Bhattacharya[2]

Key words: fern flora, enumeration of species, Saung-Pindari Trek, Kumaon Himalaya

Fern flora along the Saung-Pindari trek in the Kumaon Himalaya (U.P.) was studied during an expedition at Pindari and Kafni glaciers in June-July, 1989. A total of 30 species belonging to 23 genera have been reported. Field notes have been given on each species.

Introduction

The Kumaon Himalaya lies from 28° 45' to 30°44' N lat. and 78° 45' to 81° 5' E long. The 112 km trail from Saung to Pindari and Kafni glaciers runs mainly along the gorge formed by Pindari river through the lower ranges of Mounts Nanda Kot and Nanda Khat on the northern periphery of Kumaon Himalayas. Pindari and Kafni glaciers are situated 4,265 and 3,820 m above msl respectively.

The following account presents data regarding fern flora collected from the Saung-Pindari trek route.

Review of Literature: Beside the pioneering publication of Clarke (1880) and Beddome (1865), Duthie (1906) and Hope (1902) published literature on Kumaon ferns. More recently, Dhir (1980), Pangtey and Punetha (1987) provided information about Pteridophytic flora of different parts of Kumaon Himalayas. Khullar (1987), Pande and Pande (1991) published taxonomic accounts of the genus *Polystichum* of the Kumaon Himalaya. These works refer to the fern specimens collected from different sites along the Pindari trek.

Material and Methods

During this study, the Saung-Pindari route was visited in the last week of June 1989 to the first week of July 1989. The plants have been listed in alphabetical order. Reference has been made to Clarke (1880), Beddome (1883), Copeland (1947) and Holttum (1954) for taxonomy and related features.

Phytogeographical resume: The Kumaon Himalaya, like other parts of the western Himalaya, is wet in outer southern ranges and slightly dry in inner northern ranges. The region can be divided into three subzones.

i. Tropical and sub-tropical zone: This zone ranges between 300 m and 1500 m above msl. The natural monsoon forest extends well in this region. At higher elevations pine trees are common. Saung (1400 m above msl), the base camp of the trek, has this type of forest.

ii. Temperate zone: It commonly ranges from 1500 m to 3500 m above msl. On the trek route, Loarkhet (1759 m), Dhakuri (2690 m), Ulma (2210 m) etc. represent this zone, characterised by coniferous trees and herbs. Khati (2575 m above msl) is a small village with cultivated trees and flowering shrubs.

iii. Alpine zone: From 3500 m above msl up to the snowline, lies the alpine zone. The shrubby rhododendrons mixed with alpine pastures represent this zone. The alpine zone in the study area is represented at Phurkia (3260 m above msl).

List of Species

Adiantum capillus-veneris L. Sp. PL. 2. 1096, 1753. Loarkhet; Bhattacharya. 138; June 1989; lithophyte.

Araiostegia hymenophylloides (Blume) Copel in Philip. J. Sci. 34: 241. 1927. Dhakuri: Bhattacharya, 158, June 1989; not common.

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Asplenium trichomanes L. Sp. PL. 2. 1080. 1753. Dhakuri; Bhattacharya, 137, June 1989; epiphyte; rare.

Athyrium drepenopterum (Kunze) A. Br. ex Milde. Fil. Fur. 49. 1867. Ulma; Bhattacharya, 155, June 1989; common.

Ceterachopsis dalhousiae (Hook.) Ching. Bull. Fan. Mem. Inst. Biol. Bot. 10: 8. 1940. Dawali; Bhattacharya, 135; June 1989; on humus covered moist soil, shade loving.

Cheilanthes farinosa (Forsk.) Kaul. Enum. Fil. 212. 1824. Ulma; Bhattacharya, 139, June 1989; lithophyte.

Cheilanthes tenuifolia (Burm. f.) Sw. Syn. Fil. 129: 332. 1806. Khati; Bhattacharya, 144; June 1989; grows on moist shady rocks; common.

Coniogramme caudata (Wall ex. Ettingsch) Ching. in C. Chr. Ind. Fil. 3: 56, 1934. Phurkia; Bhattacharya, 162; June 1989; rare.

Cyathea brunoniana (Hook.) Clarke et Baker in J. Linn. Soc. 24; 409. 1888. Dawali; Bhattacharya, 151, June 1989; not common.

Cyrtomium caryotideum (Wall. ex. Hook. et Grev.) Presl., Tent. Pterid. 86.f.26. 1836. Dawali; Bhattacharya, 159; June 1989; rare.

Dryopteris sparsa (D. Don) O. Kuntze Rev. Gen. PL. 2: 613. 1891. Loarkhet; Bhattacharya, 148; June 1989; common.

Lepisorus kashyapii (Mehra) Mehra in Bir. Res. Bull. Punjab Univ. (N.S.) Sci., 13: 24. 1962. Loarkhet; Bhattacharya, 136; June 1989; epiphyte; not common.

Lepisorus leiopteris (Kunze) Bir & Tirkha, Amer., Fern. Journ. 64: 54. f. 21-26. 1974. Khati; Bhattacharya, 140; June 1989; lithophyte; rare.

Lepisorus nudus (Hook.) Ching. Bull. Fan. Mem. Inst. Biol. Bot. 4: 83. 1933. Saung; Bhattacharya, 125, June 1989 lithophyte; common.

Loxogramme involuta (D. Don) Presl. Tent. Pterid. 213, 1836. Dawali; Bhattacharya, 16; June 1989; epiphyte; rare.

Lunathyrium allantoides (Bedd.) Ching. Acta. Phytotax. Sin. 9: 72. 1964. Dhakuri; Bhattacharya, 16; June 1989; common.

Microlepia speluncae (Linn.) Moore, Ind. Fil. 93, 1857. Saung; Bhattacharya, 142; June 1989; common.

Microlepia strigosa (Thb.) Presl. Epim. Bot. 95. 1849. Phurkia; Bhattacharya, 127; June 1989.

Onychium japonicum (Thb.) Kunze Bot. zeit, 6: 507. Ulma; Bhattacharya, 141; June 1989; rare.

Osmunda claytoniana L. Sp. PL. 2: 1066. 1753. Phurkia; Bhattacharya, 128; June 1989; not common.

Osmunda regalis L. Sp. PL. 2: 1065. 1753. Ulma; Bhattacharya, 129; June 1989; rare.

Polypodioides amoena (Wall.) Ching. Acta. Phytotax. Sin. 16(4): 27. 1978. Khati; Bhattacharya, 154, June 1989 epiphyte; rare.

Polypodioides micro-rhizoma (Clarke) Ching. Acta. Phytotax. Sin 16(4): 27, 1978. Loarkhet; Bhattacharya, 132; June 1989; epiphyte.

Polypodiastrum argutum (Wall ex. Hook.) Ching. Acta. Phytotax. Sin 16(4): 28. 1978. Ulma; Bhattacharya, 143; June 1989; epiphyte; rare.

Polystichum mehrae F. Jenkins & Khullar. Indian Fern J. 2 (1&2), 10, 1985. Ulma; Bhattacharya, 149; June 1989; not common.

Polystichum squarrossum (D. Don) Fee. Gen. Fil. 278. 1850-52. Dawali; Bhattacharya, 161; June 1989; abundant in some places.

Pteridium aquilinum (L.) Kuhn. V. Deck Reis 3(3): 11. 1879. Dhakuri; Bhattacharya, 153; June 1989; common.

Pteris cretica L. Mant. PL. 7 130. 1967. Ulma; Bhattacharya, 133; June 1989; in open sunny places.

Sphenomeris chinensis (L) Taxon. Journ. Wash. Acad. Sci. 3: 144. 1913. Dhakuri; Bhattacharya, 148; June 1989: common.

Woodwardia unigemmata (Makino) Nakai. Bot. Mag. Tokyo 39: 103, 1925. Ulma; Bhattacharya, 145; June 1989; not common.

Discussion

A total of 30 species belonging to 23 genera have been collected on the Saung-Pindari trail. The only species of tree fern recorded in the present survey is *Cyathea brunoniana,* which is well distributed in western Himalaya (Dixit, 1984). Other important ferns recorded in the survey include *Asplenium trichomanes*, *Cyrtomium caryotideum*, *Loxogramme involuta*, *Onychium japonicum*, *Osmunda claytoniana*, and *O. regalis*. *Osmunda regalis* is very common in South India and Western mountains and is recorded also in Kumaon (Beddome, 1883). In the present investigation too, the fern was found only at high elevation at Ulma (2210 m). *Osmunda claytoniana* which is recorded from Kashmir to Bhutan at still higher elevations (Beddome, 1883), has been recorded from Phurkia (3260 m) during the present study. *Polystichum mehrae* reported earlier from Dhakuri, Khati, Dawali (Pande and Pande, 1991), has been found at Ulma (2210 m) during the present survey.

Acknowledgements

I thank my daughter Miss Swatoleena for help in preparing the herbarium; the C.O., 4 Assam BN N.C.C., Karimganj. for selecting me for the Saung-Pindari trekking expedition. I also thank the authorities of B.S.I., Howrah for herbarium facilities.

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NEW DESCRIPTIONS

A NEW SPECIES OF *COPIDOGNATHUS* (HALACARIDAE : ACARI) FROM ANDAMAN ISLANDS[1]

TAPAS CHATTERJEE[2]

(*With thirteen text-figures*)

Keywords: Halacaridae, Acari, *Copidognathus*, new species, Andaman Islands

A new species of Halacaridae (Acari), *Copidognathus greeni* is reported here from Chiriatapu and Chatham Island, Andaman Is.

Copidognathus greeni sp. nov.

Locality: Males and females are encountered among intertidal algal samples collected from Chiriatapu and Chatham Island of Andaman Islands.

Type: Holotype (E) and allotype (G) will be deposited in the National Pusa Collection, Entomology Division, IARI, New Delhi.

Abbreviations used in the text: AD – Anterodorsal plate, AE – Anterior epimeral plate, OC – Ocular plate, PD – Posterodorsal plate, PE – Posterior epimeral plate; GA – Genitoanal plate, GO – Genital opening, PGS – Perigenital seta, SGS – Subgenital seta, PAS – Parambulacral seta, EPI – Epimeral process I.

DESCRIPTION

Female: Idiosomal length ranged between 220 mm and 250 mm. All dorsal plates are separate and sculptured with both rosette pores and fovea (Fig. 1), AD with one anterior and one posterior areola. Anterior areola very small, bearing only a few (5-6) small rosette pores. Posterior areola rectangular bearing 8-14 rosette pores (Fig. 7). AD with first pair of dorsal setae located anterior to posterior areolae. The ds_2 on the membranous area between AD and OC. Ocular plate bears two distinct corneae and an areola comprising a few rosette pores, posterior cornea subdivided into two. OC with a strong elevated crescentic ridge extending from the lateral bar apodeme to the posterior end of the plate (Fig. 6). Posterior portion of OC tapers acutely, extending beyond the insertion of leg III. A few foveae are present on the posterior portion of OC. PD is wider posteriorly. PD narrow and conical anteriorly with a blunt truncated anterior margin. A faint ridge is present on the posterior margin of AD (just above the cuticular membrane).

All ventral plates are separate (Fig. 2). AE without areolae but with pycnotic pores. AE with three pairs of setae. PE with one dorsal seta and three ventral setae. EpI well developed and coxal in origin (Fig. 4). PE bears rosette pores dorsally, GA with paragenital areolae. GO guarded by a pair of sclerites bearing a single pair of subgenital setae near the anterior end. Three pairs of PGS present in the anterior, middle and posterior regions of GA respectively.

Gnathosoma strong, stout with rostrum tip reaching 2/3 of the palpal femur. Tectum short and acute (Fig. 5). Dorsally, gnathosoma is sculptured with fovea and ventrally with dense compact porose panels at the base on lateral margin (Figs. 5, 8), canaliculi are present in between the porose panels. A pair of proto-, deuto-, trito- and basirostral setae are present. Palp is 4-segmented. Palpal trochanter (P_1) and patella (P_3) devoid of setae, palpal femur (P_2) with

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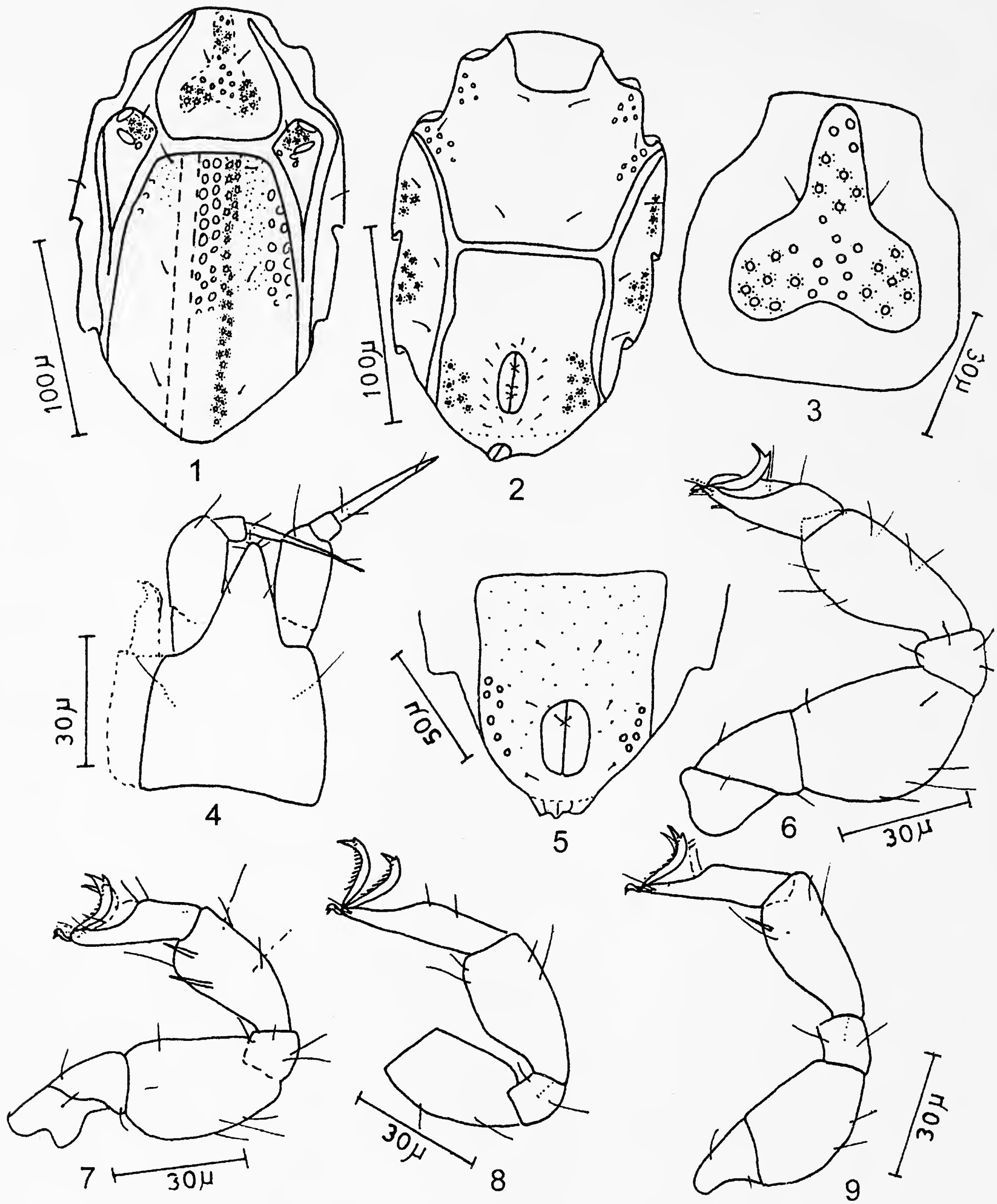
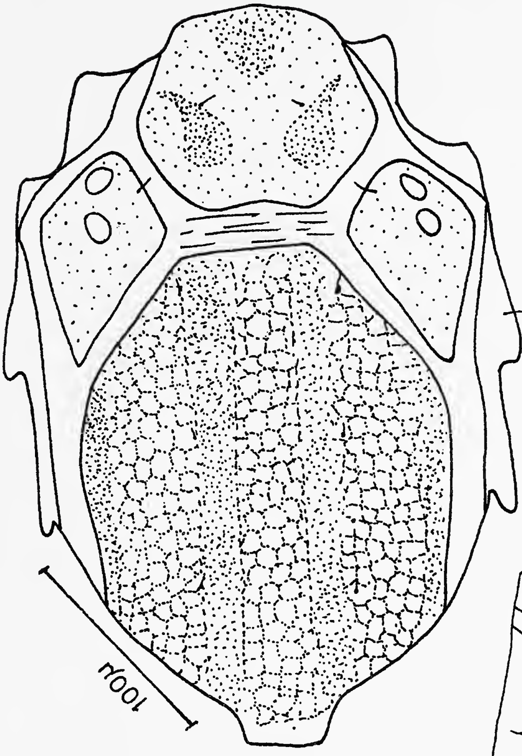


Figs. 1-9: *Copidognathus greeni* sp. nov. 1. Idiosoma dorsal (E), 2. Idiosoma ventral (E), 3. GA of G, 4. Magnified view of Epimeral process, 5. Gnathosoma, dorsal view, 6. OC, 7. Magnified view of AD, 8. Gnathosoma, ventral view, 9. Chelicera.



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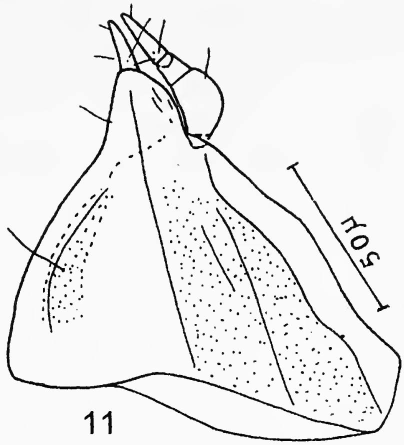

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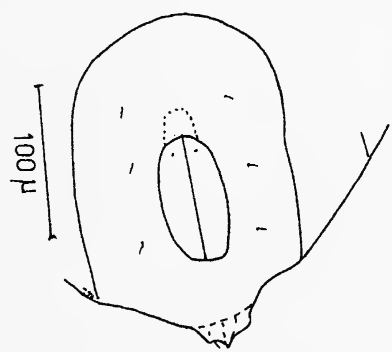

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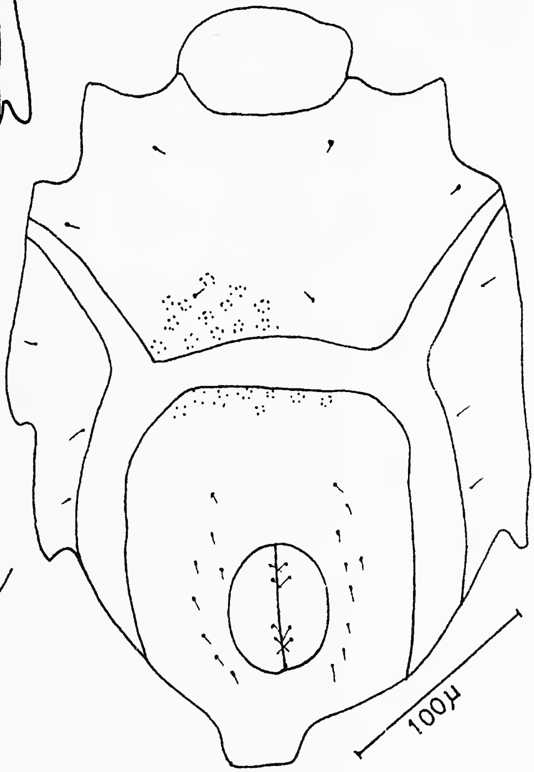

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Figs. 10-13: *Copidognathus greeni* sp. nov. 10. Leg. I, 11. Leg II, 12. Leg. IV, 13. Leg. III (Telofemur-tarsus).

one dorsal seta and palpal tibiotarsus (P_4) with three basal setae and one distal singlet eupathidia.

The chaetotaxy of legs I-IV is as follows:

Trochanter	1-1-1-0.
Basifemur	2-2-2-2.
Telofemur	5-5-2-2.
Patella	4-4-3-3.
Tibia	7-7-5-5.

Tarsus (discussed in the text)

Trochanter III clavate with a minute spine on postero-dorsal side. Telofemora I and II with ventro-distal lamellae. Distal lamellae on telofemora III and IV are feebly developed. Telofemora III and IV devoid of ventral setae. Patella I-IV and tibiae I-IV with distal lamellae. Tibiae I and II bear 4 dorsal and 3 ventral setae (two thick spine-like setae and one slender seta). Ventral margin of tibia II is highly inflated and greatly expanded, rendering the margin highly convex, while the dorsal margin of the segment is almost straight.

Tarsus 1 with 3 ventral setae (one basal filiform seta and two distal eupathidia), 3 dorsal long setae, one solenidion, one profamulus and four PAS (two double eupathidia (Fig. 10). Tarsus II with 3 dorsal long setae, 1 solenidion, 4 PAS, (Fig 11). Tarsi III and IV with 3 dorsal fossary setae, 1 proximo-dorsal seta and 2 PAS (Figs. 12, 13).

Male: Idiosomal length 208 mm to 250 mm. Male resembles the female, except for the genito-anal plate. Eight to eleven PGS are present on each side of the genital foramen. Four pairs of SGS (two pairs located anteriorly and two pairs posteriorly in the GO area) are present. The distance between GO and anterior margin of GA is almost equal to the length of GO. Paragenital areolae are present (Fig. 3).

Etymology: The species is named after Dr. J. Green, Queen Mary College, UK.

Discussion

This species is closely related to Newell's key goup 5100 (Newell, 1984) because of the presence of a well developed EpI coxal in origin, ds_2 on membranous area between AD and PD; ds_3 on PD; a single pair of basirostral setae in both males and females, and telofemora III and IV devoid of ventral seta.

C. greeni sp. nov. has many similarities with *C. oblongus* Newell 1984, of the key group 5100. In both the species, dorsal and ventral ornamentation are almost alike. Both the species have an almost rectangular posterior areola, two costae (2 pores wide) on PD, telofemora III and IV devoid of ventral setae. EpI well developed and ds_2 on membranous area. But *C. greeni* differs from *C. oblongus* in that the former has a subdivided posterior cornea on OC; rostrum extending upto 2/3 of palpal femur, three dorsal setae and one proximo-dorsal seta on tarsi III and IV, ventral margin of tibia II greatly expanded (Fig. 11). PD relatively narrow anteriorly and the distance between GO and anterior margin of GA is almost equal to the length of GO in males, while in *C. oblongus* the rostrum extends beyond the palpal patella; tarsi III and IV bear 4 and 3 dorsal setae respectively; PD widest anteriorly, GO placed more posteriorly and the distance between GO and the anterior margin of GA is more than twice the length of GO.

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A NEW SPECIES OF *PARAPSILOGASTRUS* GHESQUIERE (HYMENOPTERA : EUCHARITIDAE) FROM THAILAND[1]

T.C. Narendran[2]

(*With five text-figures*)

Key words: new species, *Parapsilogastrus*, Eucharitidae, Thailand

A new species of *Parapsilogastrus* Ghesquiere viz. *P. heratyi* is described from Thailand and compared with its nearest relative *P. fausta* (Walker).

Introduction

Ghesquiere (1946) gave the replacement name *Parapsilogastrus* for the genus *Parapsilogaster* Girault (1915). Girault gave this name *Parapsilogaster* as a replacement name for his genus *Parapsilogastroides* which he (Girault 1913) based on the type species *Eucharis fausta* Walker from Horbart Town, Van Diemen's land, Australia. Later Hedqvist (1978) synonymised *Parapsilogastrus* with *Epimetagea* Girault (Girault, 1913). However Boucek (1988) did not agree with this synonymy and he revalidated the genus *Parapsilogastrus*. He also synonymised *Epimetagea* with *Chalcura* Kirby (Boucek, 1988). The genus is so far reported only from Australia (4 species) and from Philippines (1 species) (Boucek, 1988). In this paper, the genus *Parapsilogastrus* is reported for the first time from Thailand by describing a new species. This report is in continuation of the studies on Eucharitidae by the author (Narendran 1985, 1986a, b, 1994; Narendran and Sheela, 1995).

Parapsilogastrus heratyi sp. nov.

Holotype Male: Length 3 mm. Dark metallic green with following parts otherwise: eye pale blackish brown; antenna brown; lateral ocellus reddish brown; front ocellus yellowish brown; mouth parts pale yellowish brown; legs except coxae pale yellowish brown with femora slightly darker; all coxae concolorous with thorax; wings with brownish tinge; veins and pilosity of wings brown.

Head: width in front view (Fig. 2) 1.4x its length, in dorsal view (Fig. 3) 5.6x its shortest median length; POL 1.3x OOL; vertex, frons, scrobe and genae finely striated; lower face depressed below scrobe; area below antennal toruli and upto distal margin of clypeus (face) smooth and shiny; gena and lateral portions of clypeus (except malar space) minutely punctate; one mandible with three and other with two teeth; clypeus entire with a row of eight spines; eyes bare, separated by 2x its height in front view; eye length: width = 15:12 in profile; eye length: malar space = 15:9.5. Antenna 12 segmented; scape short, stout, cylindrical, not reaching front ocellus, its length 2.1x its width; pedicel subequal, relative proportions of length divided by width of flagellar segments: F1 = 2, F2 = 1.8, F3 = 1.6, F4 = 1.5, F5 = 1.5, F6 = 1.4, F7 = 1.4, F8 = 1.3, F9 = 1.3, F10 = 2.1; length of flagellum 1.8x height of head in profile.

Thorax: dorsal side of mesoscutum with fine transverse wavy striations, dorsolateral portions rugose; metanotum longitudinally rugose; area between base of scutellum and SSS longitudinally striate, posterior vertical part of scutellum with long sparse pubescence (clearly visible from dorsal side); scutellum with U-shaped striations, interstices with shallow irregular pits; apex of scutellum truncate; length:width of middle lobe of mesoscutum :: 21:35; length from SSS to apex of scutellum 1.3x

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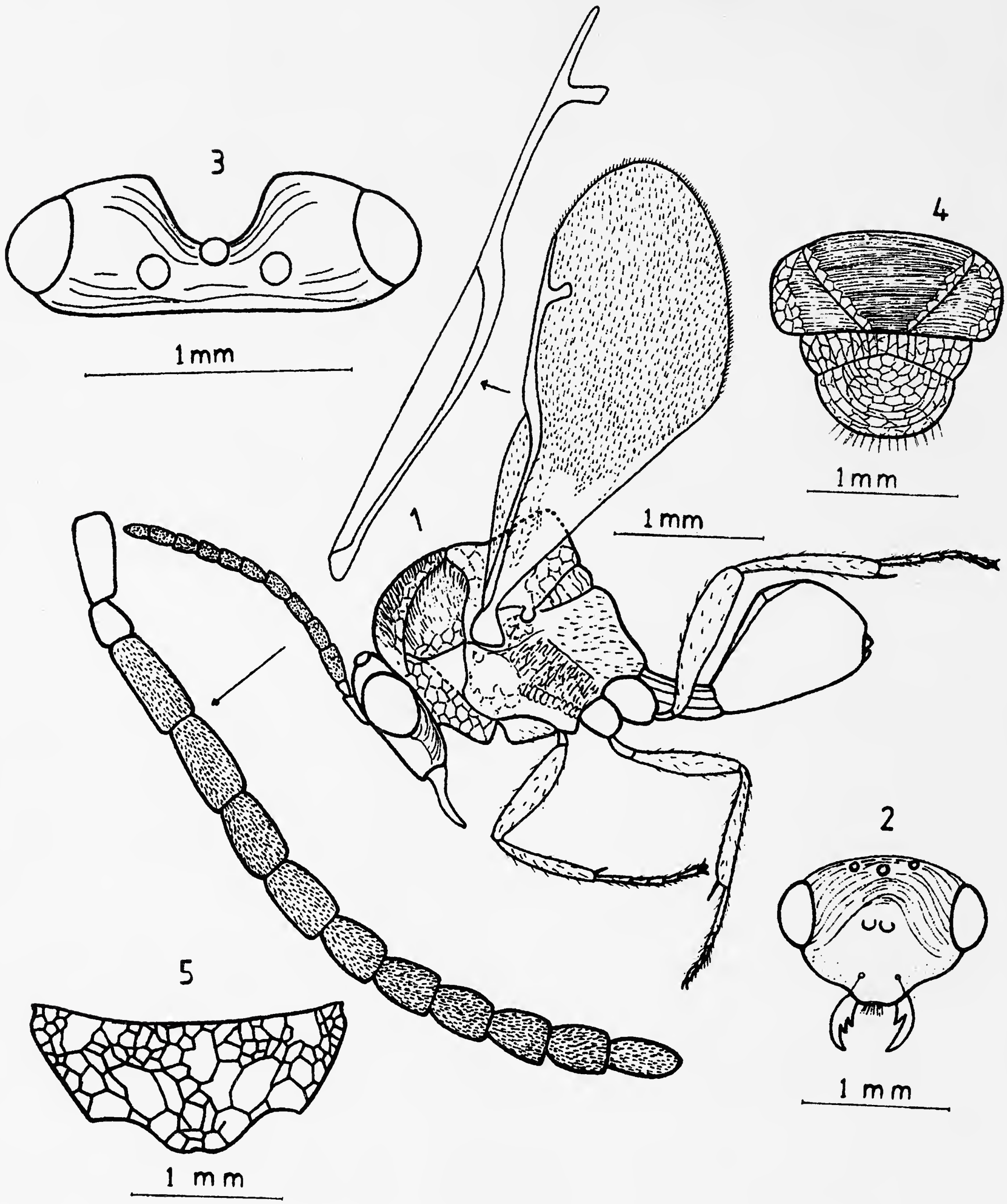

Figs. 1-5: *Parapsilogastrus heratyi* sp. nov. Male: 1. Body profile, 2. Head anterior view, 3. Head dorsal view, 4. Thorax dorsal view, 5. Propodeum.

basal width of scutellum; callus and anterolateral region of propodeum with long, sparse, brownish hairs; propodeum coarsely sculptured (Fig. 5) sides of thorax finely rugulose; front and hind coxae subequal in length; hind coxa length 1.3x its width; coxae and hind femora with scattered brown pubescence; forewing length:width :: 35:14. Lengths of forewing veins: SMV=22; MV=13; PMV=6; STV=3.

Abdomen: Petiole with longitudinal carinae on all sides; gaster smooth, shining dorsally, depressed at anterior half near petiolar margin, globose posteriorly; gastral tergites smooth and shiny.

Female: Unknown.

Remarks: This new species resembles the Australian species *Parapsilogastrus fausta* (Walker) in general appearance. However, *P. fausta* differs in having a short, upturned, finger-like carina immediately behind the frenal groove; ovate scutellum and cupreous abdomen.

Holotype: male, Thailand, Satum, Thale, Ban NP. Coll. Madl, 10-16.iii.1993 Deposited in Naturhistorisches Museum, Wien (Vienna), Austria.

Abbreviations used: F1-F10 = Flagellar segments 1 to 10. POL = Post ocellar line; OOL = Ocellocular line; MV = Marginal vein; PMV = Post marginal vein; STV=Stigmal vein; SSS = Scutoscutellar sulcus.

Acknowledgements

I thank Dr. Michael Madl of the Natural History Museum, Vienna, Austria for sincere cooperation in my studies. Help rendered by my student Dr. S. Sheela, Research Associate (CSIR) is also acknowledged.

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■ ■ ■

TWO NEW SPECIES OF *FIMBRISTYLIS* (CYPERACEAE) FROM WESTERN PENINSULAR INDIA[1]

V.P. Prasad[2] and N.P. Singh[3]

(*With two text-figures*)

Keywords: new species, *Fimbristylis*, peninsular India, Maharashtra, Karnataka

Two new species of *Fimbristylis* from western peninsular India are described and illustrated; *F. ambavanensis* from Maharashtra state and *F. simpsonii* from Karnataka state.

While working on the genus *Fimbristylis* Vahl in western peninsular India, some specimens were found to be of doubtful identity, as they did not match with the specimens and descriptions of any of the known species. The specimens were sent to Kew, where these could not be matched or identified either, and were returned to the authors. Based on these specimens, two new species are described here.

Fimbristylis ambavanensis V.P. Prasad & N.P. Singh sp. nov. (Fig. 1)

F. capilliculmis Ohwi affinis, sed foliis latioribus, stamine singulari, stylo breviore et nuce magniore differt.

Glabrous annuals with fibrous roots, *ca* 25 cm high. Stems tufted, slender, compressed, more or less flat below the inflorescence, *ca* 0.5 mm thick, striate. Leaves shorter than or as long as the stem, flat, linear, abruptly acuminate at apex, 6-18 cm long, *ca* 1 mm wide; margins infolded and thickened on the upper surface, smooth; sheaths chartaceous, striate, up to 6 cm long; ligule a fringe of short hairs; orifice membranous, oblique, minutely ciliate. Inflorescence simple or compound, lax, 0.8-1.5 cm long and as wide, with 3-12 spikelets. Involucral bracts 2-3; lowest overtopping the inflorescence, linear, 1-2.5 cm long. Primary rays 2-7, unequal, compressed, striate; longest 0.3-1 cm long. Spikelets solitary, rarely paired, ovoid to oblong-lanceolate, acute at apex, faintly angled, 3-4 x 1.5-2 mm, brown, few flowered; rachilla winged. Glumes spiral, membranous, ovate, mucronulate, keeled, *ca* 2 x 1.5 mm, brown, not prominently hyaline towards the margin. Stamen 1; filament hyaline, elongate up to 1.5 mm; anther linear-oblong, acute at apex, *ca* 0.5 mm long. Ovary oblong, *ca* 0.5 mm long, stipitate; style trigonous, pyramidally thickened at base, *ca* 1 mm long, glabrous; stigmas 3, slightly shorter than or as long as the style, scabrous. Nuts trigonous, obovoid, umbonulate, *ca* 1 x 0.6 mm, shortly stipitate, smooth, creamish-white; epidermal cells transversely oblong, in 6-8 vertical rows on each face.

Fl. & Fr.: September

Habitat: Material was collected from the top of a fort where it was common.

Holotype: INDIA, Maharashtra State, Pune dist., Mulshi Taluka, Ambavane, 6.ix.1964, Coll. B. Venkatta Reddi 99049 (CAL).

Isotypes: 99049A & 99049B (BSI).

Fimbristylis ambavanensis is allied to *F. capilliculmis* Ohwi, a Malesian species, but differs in a few characters which are shown in Table 1.

Table 1

F. capilliculmis Ohwi	*F. ambavanensis* sp. nov.
Leaves *ca* 0.5 mm wide	Leaves *ca* 1 mm wide
Spikelets solitary	Spikelets solitary or paired
Stamens 2-3	Stamen 1
Style *ca* 1.5 mm long	Style *ca* 1 mm long
Nut up to 0.7 mm long	Nut *ca* 1 mm long

Note: The specimens were compared with the illustration and description of Ohwi (1955) and Kern (1974) for *Fimbristylis capilliculmis* Ohwi.

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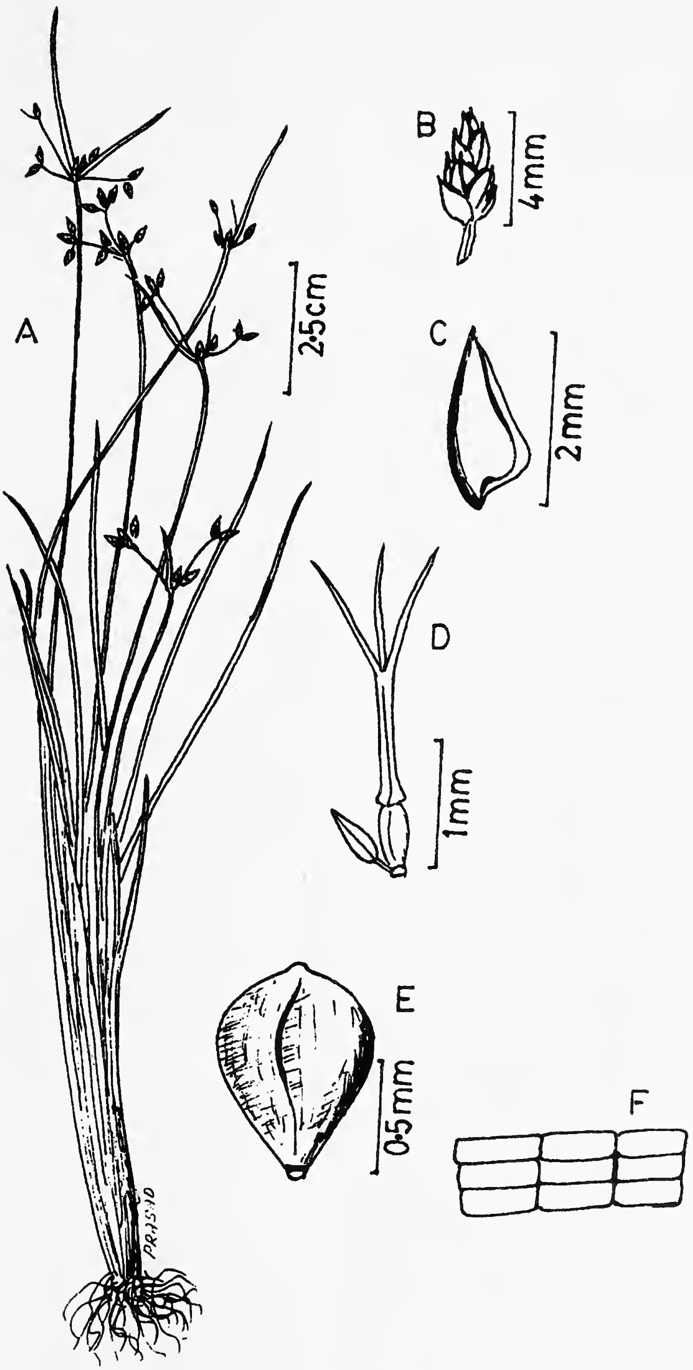

Fig. 1: *Fimbristylis ambavanensis* V.P. Prasad & N.P. Singh, *sp. nov.*
A. Habit; B. Spikelet; C. Glume; D. Flower; E. Nut; F. Epidermal cells on the nut.

Etymology: The species name is derived from Ambavane, the collection site of the holotype.

Fimbristylis simpsonii V.P. Prasad & N.P. Singh sp. nov. (Fig. 2.)

Fimbristylis bispicula Govind. affinis, sed inflorescentia spicula 1-3, staminis 3, antheris et stylis longioribus differt.

Glabrous annuals with fibrous roots, *ca* 9 cm high. Stems tufted, slender, trigonous below the inflorescence, deeply furrowed below, 0.2-0.5 mm thick. Leaves numerous, half to ¾ the length of the stem, flat, uniformly linear, abruptly acuminate at apex, 2.5-6.5 cm long, 0.7-1.2 mm wide, with slightly thickened margins; sheaths chartaceous, up to 1.5 cm long; ligule a fringe of short hairs. Orifice membranous, ciliate. Inflorescence simple, with 1-3 spikelets, 5-8 mm long, 6-13 mm wide. Involucral bracts 1 or 2, much shorter than or as long as the inflorescence, short laminate or glume-like with an awn, 2-7 mm long. Rays if present trigonous, striate, 2-4 mm long. Spikelets solitary, ovoid to oblong-lanceolate, acute at apex, slightly angled, 3-4 x 1-1.5 mm, brown, few-flowered. Rachilla winged. Glumes spiral, ovate, acute-mucronate at apex, strongly keeled, 1.8-2 x 1.2-1.5 mm, hyaline towards margins but brown lineolate. Stamens 3; filaments hyaline, elongate up to 2 mm; anthers linear-oblong, subacute at apex, *ca* 0.6 mm long. Ovary linear-oblong, *ca* 0.5 mm long; style triquetrous, slightly thickened towards the base, *ca* 1.2 mm long, brownish, glabrous; stigmas 3, about half the length of the style, scabrous. Nuts trigonous with 2 convex faces and 1 flat face, obovoid, minutely umbonulate, shortly stipitate, 0.8-1 x 0.6-0.7 mm, smooth or verruculose, creamish-white; epidermal cells transversely elongated, in *ca* 4 vertical rows on each face.

Fl. & Fr.: August

Habitat: Rocky slopes near rivulets. Very common.

Holotype: INDIA, Karnataka state, Shimoga dist., Tirthahalli, Kanagalgudda. 19.viii.1963. Coll. R. Sundara Raghavan 90025 (CAL).

Isotype: 90025 A (BSI).

Fimbristylis simpsonii shows close affinity to *F. bispicula* Govind. in many respects but differs in the following characters (Table 2).

TABLE 2

F. bispicula Govind.	*F. simpsonii* sp. nov.
Inflorescence one pair of spikelets	Inflorescence with 1-3 spikelets
Stamens 2	Stamens 3
Anthers 0.2-0.3 mm long	Anthers *ca* 0.6 mm long
Style *ca* 1 mm long	Style *ca.* 1.2 mm long

F. simpsonii can also be compared with *F. tenera* R. & S., which has no ligule but has more spikelets, larger involucral bracts, rays, spikelets and glumes, smaller number of stamens and hexagonal epidermal cells in 8-10 vertical rows on the nut.

Etymology: This species is named after Dr. David Simpson, Royal Botanic Gardens, Kew in honour of his valuable work on aquatic angiosperms and on family Cyperaceae.

With the addition of these 2 species, the total number of endemic species of *Fimbristylis* in peninsular India has increased to 39, and for the whole of India 48. It may be mentioned that Prasad & Singh (1997a) reported 30 endemic species of *Fimbristylis* from peninsular India and 37 from the whole country, and later on updated the numbers as 37 and 46 respectively (Prasad & Singh 1997b).

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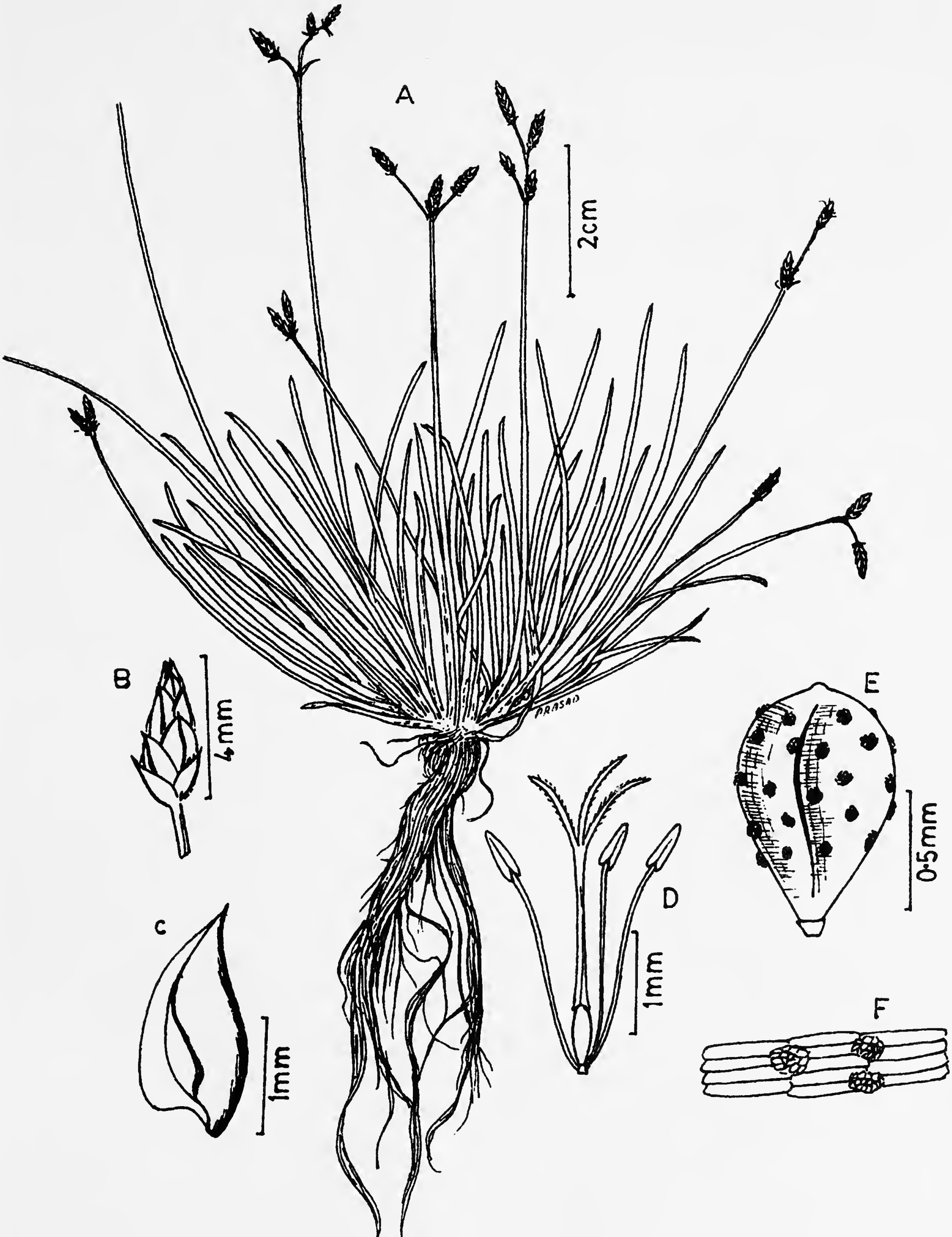

Fig. 2: *Fimbristylis simpsonii* V.P. Prasad & N.P. Singh, *sp. nov.*
A. Habit; B. Spikelet; C. Glume; D. Flower; E. Nut; F. Epidermal cells on the nut.

for his expert opinion on the identifications and Dr. Sri Krishna Murti, ex-Indian Liaison Officer at Kew for his keen interest in getting these specimens identified and for the literature.

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REVIEWS

1. PLANT TISSUE CULTURE AND BIOTECHNOLOGY — EMERGING TRENDS, edited by P.B. Kavi Kishore. Published by Universities Press (India) Ltd., Hyderabad, 1999, hardbound price Rs. 525/-, pp. xiii+314. (24 x 16 cm).

The book provides a very broad spectrum of research presently being undertaken in plant tissue culture in the various University Departments throughout India as well as in a few research institutions and national research laboratories.

The book is a compilation of 50 research papers presented at a symposium on 'Emerging Trends in Plant Tissue Culture and Biotechnology' held at Hyderabad in 1997.

From the various articles, it is apparent that the major thrust of research on plant tissue culture in India is on micropropagation, for as many as 20 out of the 50 papers included in this volume deal with this topic, while only 5 papers deal with secondary metabolite production. The remaining papers dwell on a vast range of topics such as: somaclonal variations, anther culture, stress tolerance, nodule initiation, and hairy root culture. In fact, there are only 2 papers on molecular biology. The volume also includes 4 papers of general interest to researchers in this field; these papers provide essential information on seed proteins, plant growth regulators, oxidative stress, calcium channel blockers, etc.

Nevertheless, this publication has its own place in current literature on plant tissue culture, as it provides first hand information on problems associated with tissue culture of a very wide range of plant species extending from ornamentals to the more useful commercial varieties, be they medicinal (*Withania*, *Boswellia*, *Alpinnia*, *Bacopa*), fruit bearing (*Achras*, papaya, litchi, cashew), aromatic (vanilla) or even wheat and pulses. The information, particularly on tree species, will be of great use to prospective researchers as there are enumerable problems associated with their culture techniques which plant tissue culturists generally avoid because of the difficulties involved in raising such plantlets in the laboratory.

In summary, this volume will be a good addition to reference sources for scientists and students engaged in plant tissue culture.

■ S.M. KARMARKAR

2. FLORA AND FAUNA IN MUGHAL ART, edited by Som Prakash Verma. Marg Publications, Mumbai,1999, hardbound price Rs. 1950/- (US$ 60), pp. 164+8 (33 x 25 cm).

Ever since I read Dr. Sálim Ali's papers in *JBNHS* (Vols. 31 & 32, 1926-27) and Prof. S.M. Alvi and A. Rahman's book JEHANGIR THE NATURALIST, nearly 25 years ago, I wanted to know more about wildlife during the Mughal period. Marg Publications wins praise for bringing out a magnificent book FLORA AND FAUNA IN MUGHAL ART. This 33 x 25 cm coffee-table book is lavishly illustrated by some of the best painters of the Mughal period, including the legendary Mansur. The description of paintings is illuminating and helps in identifying minute details which one would otherwise miss.

To enjoy the details, many paintings are published full-scale (e.g. p. 104, 105) but some paintings are small. For example, on page 39, Akbar watching elephant catching near Sipri is so awesome that I wish it was published full scale to appreciate the beauty of this work of art by Keshav Khwurd. Interestingly, the original painting is 32 x 20 cm, but unfortunately, it has been miniaturized in this book.

I was particularly saddened to know that most of the paintings are not present in Indian

museums. Out of the 118 paintings illustrated in this book, only 14 are present in India. Eighteen are the property of the Victoria and Albert Museum, 24 are in private collections outside India, 30 are in various other museums, 11 each in New York and Tehran, 5 in Los Angeles, and so on.

While most of the chapters are interesting, I was specially fascinated by the importance of the elephant in Mughal paintings by Asok Kumar Das. Another erudite chapter is on mythical animals, their images, symbols and allusions, by Philippa Vaugham. Scenes of hunting in Mughal paintings are described by Divyabhanusinh, who has recently written a highly readable book on the cheetah in India.

It is difficult to describe the beauty and scientific accuracy of each painting in this brief review. Go and get this book. You will enjoy it. It is worth two thousand rupees.

■ ASAD R. RAHMANI

3. SNAKES IN INDIA, edited by B.D. Sharma, Asiatic Publishing House, 1998, Hardbound price Rs. 995 (US$95), pp. xvi+352, 33 fig., 33 plates, (22 x 14 cm)

According to the not so subtle subtitle, this book is "An indispensible (*sic*) book on Indian snakes, their ecology, conservation and clinical study". This volume is, in this reviewer's opinion, almost wholly dispensable. The first draft of this review was a blow by blow (actually chapter by chapter) account of this disastrous production but it ran to 6 long pages. This is an edited version which samples some of the classic blunders.

With a few exceptions, the illustrations are either poor to begin with, printed badly or both. Many pictures are twisted, preserved specimens; one is sideways (Pl. 37), several are misidentified (Pls. 17, 19, 20 and 21) and one is actually a negative image (Fig. 30)! The pictures serve little purpose since they are so unclear as to render them useless in helping to identify the random collection depicted, and as a result also render the associated Chapter 8 worthless. Fig. 3 on page 29 shows the profile of a cobra's head, but with its eye situated where the nostrils ought to be. Fig. 5 on page 31 is the crosssection of a cobra fang, not a viper fang. The Russell's viper photo in Fig. 21 was taken by me, not my friend Dr. Vad as credited. That's just the illustrations!

The Preface informs us that "the up-to-date" bibliography of 666 references contains "almost all published works on Indian snakes." Of these, I found only 5 references dating to the 1990's. The real number of published works on Indian snakes is probably about ten times the number in this bibliography.

Chapter 1 (by Anil Khaire) is one of the few that stand out. It is a nice, simple description of snakes in general, obviously written by someone who likes and knows them well. Chapter 9 by T.S.N. Murthy is also a well written but dated piece, dealing with the venom systems in snakes. Perhaps the most important fact brought to the fore is that snakebite is rarely fatal and that fast administration of antivenom serum is of prime importance. Advice, however, for avoiding snakebite is "just avoid snakes"! The editor is responsible for Chapters 2 to 8 (except 6) and though you can find some useful facts therein, you must read through a lot of poorly edited shoddy writing, rife with confused facts. Need a few examples? Try page 9, where the author states that 'in India alone 15,000 to 30,000 people die of snakebite' and a few sentences later says that "deaths due to snakebites in India alone tune to two million per year"! And in Chapter 3 the casualties come down to a lakh of people each year. On page 14, the author repeats an error started by P.J. Deoras in his book SNAKES OF INDIA that in a cobra fang "the venom simply trickle (*sic*) down the groove of the fang".

Chapter 3, item 20 states that the author feels that people die from snakebite mostly due to "fear of death", I don't think many medical doctors would subscribe to this oft-repeated myth. It's not that easy to die of fright unless you have a weak heart or faint over the edge of a cliff.

Scientific fact no. 39 is titled "Cobras and the kind (*sic*) cobras are the hooded terrors among the venomous snakes." In a book purporting to "dispel the fear and detest in the minds of the people", the purpose is defeated by such statements.

Table 4 of Chapter 4 infers that the Himalayan pit viper is an ant eater. Did it not occur to the researcher that the ant remains were from the stomach of much more likely food items (digested earlier) namely lizards and amphibians?

Chapters 6 and 16 are ones I'm partly to blame for. Both were written 30 and 20 years ago respectively. While the first isn't worth much, the second (on snake conservation) is not too bad but very out of date.

Impatiently going down the checklist of Indian snakes in Chapter 11, I noted at least 20 omissions (*Ahaetulla prasina*, *Lycodon laoensis*, *Lycodon capucinus*, *Eryx whitakeri* – my single claim to immortality!) and several errors. Since 1990, the three Indian cobras have been given full species status. *Vipera russellii* is now *Daboia russelli* and several pit vipers have been renamed.

In Chapter 12, besides wrong statements like "cobra venom is the most potent venom known", it is stated that Russell's vipers cause more deaths than cobras "due to its unflinching fatal bites". A humorous choice of words but untrue; cobras, just by being so common, almost certainly cause more bites, and deaths, than any other Indian snake.

The checklist of the snakes of the northeast in Chapter 14, by R. Mathew, omits *Naja kaouthia* (monocellate cobra). I didn't go through the list carefully but no doubt several more are missing.

Chapter 15 by S.K. Talukdar is on the ecology and conservation of snakes. He put me off immediately by calling snakes "repulsive creatures" in the first paragraph. Repulsive authors is more like it! And moreover he tries to credit me for more than I deserve – I seem to have "recorded" a 33 foot long reticulated python in the Nicobar Islands! Having not set foot on the islands, I wonder how I was bestowed the honour of "recording" this mythical creature. Then he says that this python is "the most threatened amongst the Indian serpents" which is way off the mark.

The meaty, fairly current stuff comes from the highly respected American snakebite and venom expert, Sherman Minton. Although it is only 4 pages long, Chapter 17 deals with the relationships of Asian venomous snakes as evidenced by comparing proteins in snake blood serum. We're so used to looking at snakes as evidenced by comparing proteins in snake blood serum. We're so used to looking at snakes and aligning them by their external characteristics that the results of this kind of study (and DNA comparisons) are sometimes a jolt. Dr. Minton moves on to a generalized discussion of snakebite in Chapter 18. Though brief, it brings us up to date and discusses some of the obsolete (and sometimes dangerous) first aid measures. In Chapter 19, Dr. Minton lists the species of snakes generally considered to be non-venomous but which actually have toxic saliva and can cause serious bites. Several of them have relatives here in India and he cautions that we should be careful with snakes like the checkered keelback, olive keelback and some of the cat snakes. Chapter 20, also by Dr. Minton introduces the venom detection test using ELISA which is available in American and Australian hospitals and can be used to confirm envenomation (useful when the snake is not seen or symptoms are slight). This system is not in use in India but it would be very helpful. Chapter 21 is on rattlesnakes. Though interesting, why is it in this book on Indian snakes?

Chapter 22 is a lengthy discourse by

Australian snakebite authority Dr. Straun Sutherland. The only problem is, it's about the treatment of bites by Australian snakes! Useful for the Indian tourist planning to visit Australia, I suppose.

By this time the reviewer is very weary with this tome and sure enough my apprehensions are justified. Here's a quote from Chapter 23 by N.P. and S.C. Misra: "the tapering part of the body (of a snake) has greater capacity of movement has been called tail". And how about this howler: "these sea snakes cause more deaths in America than any other variety... Most of the snakes in sea non-poisonous. Various types of rattlesnakes belong to this variety," (Phew! And omigod!) In fact, dear reader, only one species of seasnake occasionally ventures as far as Central America (*Pelamis platurus*). All seasnakes are highly venomous and rattlesnakes are certainly not related to seasnakes!

Chapter 25 is engagingly titled 'Snakebite Disease in Jammu' by R.N. Bhatt. I won't comment on the minor blunders but just read this one for flavour: "one strong lucky man gave history that a large cobra, which he had brought along after killing it, had pursued the person from his own compound to a nearby house." And the author ends with this advice: "People living in tents must built (*sic*) snake trenches around the tents which prevent snakes from crossing over sharp stones." Make of it what you will.

Chapter 26 has this advice, "even a thin layer of clothing may afford great protection" from snakebite – don't ever try it! Chapter 27 by I. Jena and A.P. Dash is on snakebite in Orissa and is not a re-hash but quite an interesting, brief analysis of the situation in that very snakey state. Deaths by cobra and krait are high and it could partly be because the antivenom used there is made from snake venoms from other parts of the country — venoms in the same species can differ that much!

Readers may think this review is a bit hard on the Editor and some authors. I think that it is a crime to produce such books in the name of Indian science and to shamelessly publish decades old facts as if they were current. This is especially dangerous when publishing first aid measures for snakebite that are obsolete. In scientific circles abroad, this book will make us a laughing stock and anyone overseas paying US$ 95 for it (that's Rs. 4,000!) would certainly not trust scientific publications from India anymore. If there is no law already against producing such low-grade work, the Indian scientific community should make one!

■ ROMULUS WHITAKER

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MISCELLANEOUS NOTES

1. HOUSE SHREW *SUNCUS MURINUS* (LINNAEUS) FEEDING ON AN OLIVE KEELBACK WATER SNAKE *ATRETIUM SCHISTOSUM* (DAUDIN)

The house shrew *Suncus murinus* is known to be aggressive to animals much larger than it in size, like the house crow, domestic dog or large bandicoot rat, and is capable of defending itself (Mandal 1984, Biswas and Mandal 1984, Pradhan 1980). It is also reported to attack frogs and toads (Dharmakumarsinhji 1946, Sharma 1992, Tiwari 1994), snake (Behura 1958), gerbille (Saini and Parshad 1994). But there is no record of its feeding on a snake. Behura (1958) observed a house shrew dragging a keelback water snake *Natrix stolata* into his house. I had the opportunity of observing a house shrew feeding on an olive keelback water snake *Atretium schistosum.*

On November 9, 1998, at about 1725 hrs. I observed that a male house shrew had seized a snake (approximately 25 cm long) by its lower jaw and dragged it towards a small bush by the side of a pond, in front of Beledanga Primary School, Shakuntala Park, Calcutta. As this snake has a very sluggish nature, it did not make any violent movement. When I approached, the shrew left the snake and hid itself among the bushes. I retreated a few steps and watched the scene from a distance of about 4 m. The snake moved its head, body and tail slowly. After a while, the shrew came out of the bush, seized the snake again by its lower jaw, and dragged it inside the bush. Within two minutes, I heard the crushing sound of some hard parts from the bush. After half an hour, I approached the site with a torch, and found that the shrew had eaten about 3-4 cm of the snake, starting from its head region.

May 3, 1999

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2. RUSTYSPOTTED CAT *PRIONAILURUS RUBIGINOSUS*, A NEW RECORD FOR NAGARJUNASAGAR SRISAILAM TIGER RESERVE, ANDHRA PRADESH

On April 30, 1998, a fresh carcass of a cat was seen around 0630 hrs on the road near Buredupally Bhavi towards Vatavarlapally on the Amrabad Plateau of the Nagarjunasagar Srisailam Tiger Reserve. Closer observation revealed a soft tawny coat with a rufous tinge

that was patterned with transverse lines of small rusty-brown spots forming solid stripes along the back of the head. The chin and the undersides of the forearms had dark brown stripes. The white underside had black spots. Based on these characteristics, the animal was identified as the rustyspotted cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire, 1831) – a new record for the Nagarjunasagar Srisailam Tiger Reserve.

IUCN (1996) and Acharjyo *et al.* (1997) report it to be widespread in southern India, but nowhere is it common; considering the patchy and infrequent collections and observations of Gee (1964), Prater (1971), Chakraborty (1978), Pathak (1990), Chavan *et al.* (1991). Tehsin (1994) and Digveerendrasinh (1995).

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3. SIGHTING OF THE CARACAL *CARACAL CARACAL* IN JALORE DISTRICT, RAJASTHAN

Shri Pradeep Singh, Pradhan Panchayat Samiti, Jalore, Rajasthan, informs me that he has seen two caracal near village Takhatpura, tehsil and district Jalore, in February, 1998 and that he was able to watch them for a good twenty minutes. Shri Pradeep Singh affirms that he is certain that what he saw were not jungle cats (*Felis chaus*). "The black tufts on the ears were very distinctive and the short tail assured me that what I was watching were not jungle cats. Unfortunately, I did not have a camera with me that day." I have known Shri Pradeep Singh for some years and can vouch for his veracity and ability to distinguish a jungle cat.

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4. DISTRIBUTION OF THREE RODENT SPECIES IN THE HILLY TRACTS OF RAJASTHAN

(*with one text-figure*)

Three genera of rodents, *Millardia, Golunda* and *Bandicota* are Oriental in origin and geographical distribution. During the last century, their distribution was recorded as restricted in peninsular India, mostly in mesic environment, specially in better-watered tracts (Blanford, 1888-91; Jerdon 1874). Very little information is, however, available about their occurrence in the hilly tracts of Rajasthan except in Report No. 12 of the BNHS Mammal Survey of India. The report was based on a series of mammals collected by Crump at Mt. Abu located in the extreme south of the Aravalli range (Ryley, 1913). According to this report, *G. ellioti* was found to be 'common' and *B. bengalensis* as 'rare' in the Archaean granite rock system. Eighty years later, we undertook a study of the small mammals at Mt. Abu more or less at the same spot as described by Crump. It has been revealed that the relative abundance of these two rodents has drastically altered. Golund are found to be 'very abundant' and the bandicoot 'common'. This change has been attributed to the drastic denudation of the forests, alteration in the landuse pattern and recent introduction of irrigated agriculture on the hills. *Millardia meltada* was not reported by Ryley (1913), but was collected by us during 1993 and 1994 from the foothills of the Abu hill (Prakash *et al.* 1995).

A comparison of the data on small mammal abundance from earlier studies in the desert districts adjoining the Aravalli range (Prakash 1955, 1962, Prakash *et al.* 1971) with data on the main Aravalli range (Prakash *et al.*, 1995) revealed that the peninsular rodents are gradually invading the Aravallis and the southeastern Thar desert (Prakash, 1995). They have not been collected in districts away from the Aravalli.

Later, we extended our studies on the ecology of small mammals to the low Aravallis of Udaipur - Dungarpur and the Kota-Bundi-Ranthambore zones, the Vindhyan rock system in Banswara section in southern, and Jhalawar in southeastern Rajasthan (Fig. 1). Small mammals were trapped at 19 localities by laying two trap lines with 30 snap traps each, in six habitats at each locality. Since the number of traps varied at each habitat and locality, we have transformed the capture data to 700 traps to bring about similarity in trapping effort. Fig. 1 shows the abundance of the three rodent species in the two study zones. In both the zones, these rodents are unevenly distributed and their occurrence is discontinuous. *M. meltada* was collected at Banswara and Shahbad, both located near the peninsular region and south of rivers Mahi and Chambal (Fig. 1). *G. ellioti* occurred north and south of the rivers (Table 1), but in the northern region its abundance was considerably low. In the southeastern region, the variance was statistically significant ($X^2_{(1)} = 51.94$, $P < 0.001$). In southeastern region *B. bengalensis* was also trapped south of the Chambal river though in the Udaipur - Banswara zone it was caught at

TABLE 1
DISTRIBUTION OF THREE RODENT SPECIES IN THE HILLY TRACTS OF SOUTH AND SOUTHEASTERN RAJASTHAN

Region	No. of specimens		
	Millardia meltada	*Golunda ellioti*	*Bandicota bengalensis*
South Rajasthan			
North of River Mahi	0	14*	5
South of River Mahi	5	20	0
Southeastern Rajasthan			
North of River Chambal	0	6	0
South of River Chambal	35	68	20

* The number of specimens of each species has been corrected for equal number of traps (700).

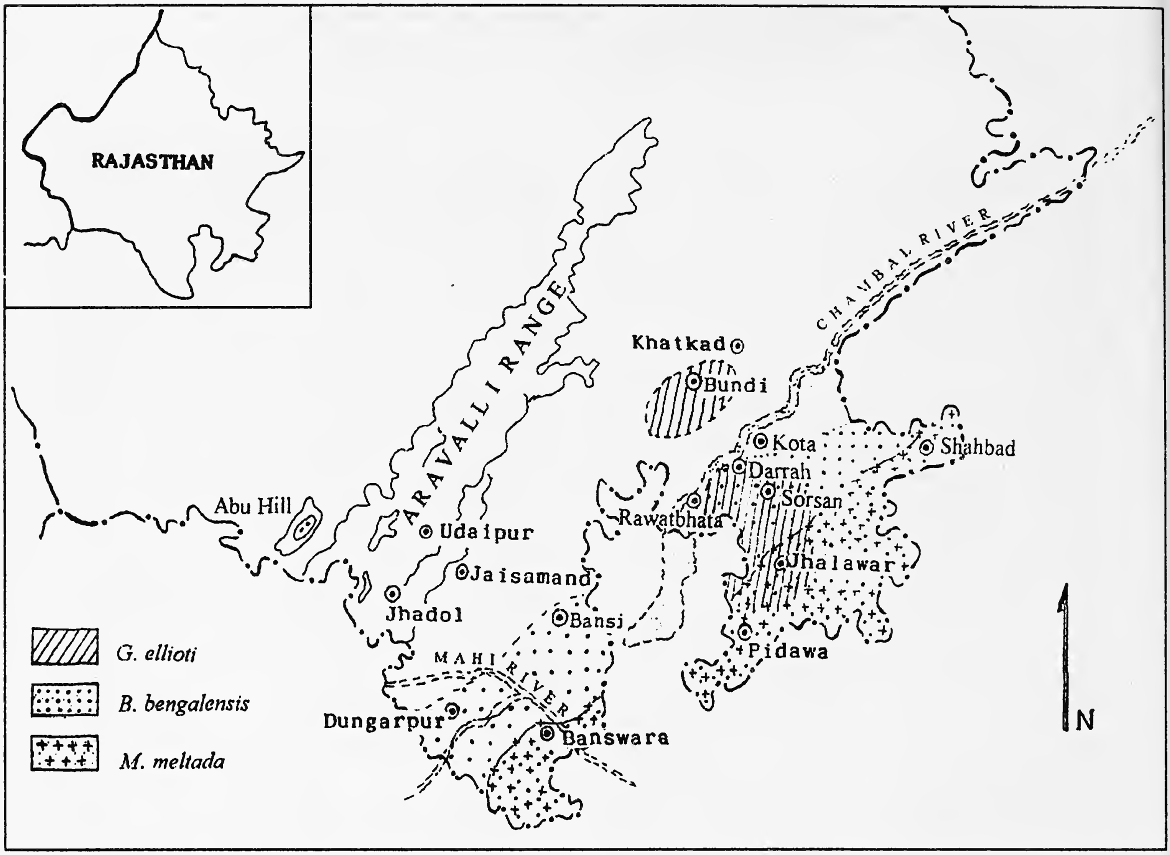

Fig. 1: Discontinuous distribution of the three rodent species

Bansi and Udaipur located north of the River Mahi (Fig. 1).

The wider distribution of bandicoot is due to its aggressive and exploratory behaviour, and adaptability. It can alter its ecological niche from that of a wild rodent to a peri-domestic rodent, and it is well known to shift even to godowns as a residential pest of foodgrains (Spillet, 1968).

The gradual decline in the abundance of these species in a south-north direction in southern and southeast Rajasthan upholds the conjecture that these peninsular elements are gradually moving northwards. A plausible explanation for their range expansion may be that it is a consequence of man's intervention in the natural ecosystem. Forests have been drastically denuded and have been transformed into irrigated crop fields. Since 1951, the irrigated area has increased more than twelve times (Moghe, 1994). Consequently, adequate soil moisture regime is available to these burrowing rodents for the whole year, and this is conducive to these mesic species. Prior to expansion of irrigation, the soil used to be moist only during the monsoon.

Our studies also suggest that the rivers Mahi and Chambal may be functioning as barriers in their northward migration.

May 20, 1999

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5. SOME FOOD PLANTS OF CHITAL (*AXIS AXIS*) IN RAJAJI NATIONAL PARK, INDIA.

While studying chital habitat use in and around Dholkhand, Rajaji National Park, India, during November 1992 - May 1993, we observed some plant items fed upon by chital. Observations were either direct (i.e. seen in the chital's mouth) or indirect (i.e. fresh signs where the chital had just fed). Binoculars (8 x 30) were used. We report our findings, which, incidentally, seem to be the northwestern-most record on chital food preferences in India.

The species and plant parts eaten are listed in Table 1. We did not see, but strongly believe from our observations on chital behaviour, that leaves of *Acacia catechu*, *Terminalia bellirica*, *Adina cordifolia*, *Carissa opaca*, and fruits of *C. opaca* and *Bauhinia racemosa* were also eaten.

Of the 35 species we have listed, 9 are being reported for the first time (Table 1), while 26 have already been documented in one or more of seven earlier reports in India. Our observations also suggest that food preferences of chital differed with seasons, availability and palatability.

TABLE 1
SOME FOOD PLANTS OF CHITAL IN THE PARK

Plant species	Part eaten	Remark
Ageratum conyzoides	stm + lf	stm & lf together
Anogeissus latifolia	lf	
**Arabidopsis thaliana*	stm + lf (nf)	Available and eaten only in March-April
**Arenaria serpyllifolia*	stm + lf (nf)	Available and eaten only in March-April
Bridelia retusa	lf	
Blumea sp.	stm + lf	
**Carex* sp.	lf	
Chloris dolichostachya	nf	
Chrysopogon fulvus	nf	
Cordia obliqua	lf	
Crotalaria sp.	stm + lf	
Cynodon dactylon	stm + lf	
Cyperus kyllingia	stm + lf (nf)	
Dendrophthoe falcata	lf	
Desmostachya bipinnata	lf (nf)	
**Dicliptera roxburghiana*	stm + lf	
**Eulaliopsis binata*	nf	Only nf from cut stock eaten
**Gnaphalium leuteo-album*	stm + lf (nf)	Available and eaten only in March-April
Helicteres isora	lf (nf)	
Heteropogon contortus	lf (nf)	
Ichnocarpus frutescens	stm + lf	
Imperata cylindrica	nf	
Justicia simplex	stm + lf	
Lantana camara	lf	

ACKNOWLEGDGEMENTS

We are very grateful to the Uttar Pradesh Forest Department, the Director and the staff of

TABLE 1 (*contd.*)
SOME FOOD PLANTS OF CHITAL IN THE PARK

Plant Species	Part eaten	Remark
Mallotus philippinensis	lf	
**Neyraudia arundinacea*	stm + lf	
**Shorea robusta*	p + inf	Available and eaten only in April-May
Sporobolus diander	nf	
**Stellaria media*	stm + lf (nf)	Available and eaten only in March-April
Terminalia tomentosa	lf	
Urena lobata	stm + lf	
Vetiveria zizanioides	nf	nf from burnt stock
Zizyphus xylopyra	lf, ft	
Z. mauritiana	ft	Seen from carcass
Malvaceae member	stm + lf	Probably *Malvastrum coromandelianum*

(stm = stem, lf = leaf, nf = new flush, ft = fruit, p = petals, inf = inflorescence); * First record, to our knowledge.

Rajaji National Park who kindly facilitated our study; WCU (IUCN) funded it through Wildlife Institute of India.

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6. BIRDS FORAGING ON TREE TRUNKS

On several occasions, while studying woodpeckers at the Peechi - Vazhani Wildlife Sanctuary (Thrissur dist., Kerala), I came across birds other than woodpeckers foraging on tree trunks either in association with woodpeckers or all by themselves. I report here some of these observations. It may be stated that there was no systematic effort to gather this data as it was not the focus of my studies.

Eleven species of birds from eight families

TABLE 1
BIRDS SEEN FORAGING ON TREE TRUNKS

Species	# Obs.	Association with woodpeckers	Food consumed
Meropidae			
Bluebearded Bee-eater* (*Nyctyornis athertoni*)	1	-	I
Capitonidae			
Small Green Barbet (*Megalaima viridis*)	2	-	T; I
Dicruridae			
Grey Drongo (*Dicrurus leucophaeus*)	1	-	I
Racket-tailed Drongo (*D. paradiseus*)	5	2	I
Sturnidae			
Whiteheaded Myna (*Sturnus malabaricus*)	4	1	I; T
Corvidae			
Treepie (*Dendrocitta vagabunda*)	2	2	I
Campephagidae			
Large Wood-Shrike (*Tephrodornis virgatus*)	4	-	I,S,T
Pycnonotidae			
Redwhiskered Bulbul* (*Pycnonotus jocosus*)	2	2	T
Redvented Bulbul* (*P. cafer*)	7	5	T, I
Muscicapidae			
Jungle Babbler* (*Turdoides striatus*)	1	1	T
Paradise Flycatcher* (*Terpsiphone paradisi*)	1	-	I

(Note: T -Termites; I-Insects; S-Spiders)

were seen foraging on tree trunks in 30 instances during the period September 1991-May 1993 (excluding the three months June-August 1992). The results are summarized in Table 1.

Birds were seen foraging on tree trunks in all months except November. Many of the birds were noticed feeding on termites, and quite a few were also seen feeding on other insects and spiders. Some of the birds were seen following the goldenbacked (*Dinopium benghalense*) or little scalybellied woodpeckers (*Picus xanthopygaeus*), often only a few centimetres away. Woodpeckers were seen displacing or attacking these birds on four of the thirteen instances when they were seen together. While six of the eleven bird species are known to forage on tree trunks, the others (marked with asterisk in the table) are not known to do so.

Whitten (1982) reported spangled drongos (*Dicrurus hottentotus)* taking ants from tree trunks on Siberut Island, Indonesia, where woodpeckers are absent and taking insects from a dead tree on North Sulawesi, where just one woodpecker species occurs. He could not find instances of such behaviour in the Sunda Region where at least seven woodpecker species live sympatrically, and so he suggested that where woodpeckers are absent, the spangled drongo is able to occupy part of the vacant niche.

It is, therefore, interesting to find at least 11 species, in addition to the velvetfronted nuthatch (*Sitta frontalis*), foraging on tree trunks in my study plots in Peechi -Vazhani area, where eight woodpecker species also occur.

Acknowledgement

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October 27, 1997

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Reference

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7. THE NODDY TERN (BROWN NODDY) *ANOUS STOLIDUS* OFF THE SOUTH KONKAN COAST

On September 9, 1997, during one of my infrequent visits to the Vengurla Rocks, which lie about 9 nautical miles off Malwan, Sindhudurg dist., Maharashtra, I observed 18 noddy terns on Burnt Island, the landward-most rock of the tiny archipelago. Perched in small groups on rock ledges and on boughs of stunted vegetation on the leeward side of the rock, they showed little inclination to take part in the frenzied feeding activity of an estimated more than 4000 roseate terns *Sterna dougallii*, over 300 brownwinged (bridled) terns *Sterna anaethetus* and over 200 large crested terns *Sterna bergii* that were milling around the island. On a follow-up visit on September 30, 1997, G. Frost, N. Manville and I had a short sighting of a single noddy tern on the wing, while there was no sign of any during a pre-monsoon visit on June 5, 1997.

The noddy, a purely pelagic tern, is known to breed in the Lakshadweep (Laccadive) Islands, specially on Pitti Atoll, about 570 km SSW of the Vengurla Rocks. It has been recorded as a straggler on the coasts of Sri Lanka and Pakistan (Handbook 3:71). The sightings on Burnt Island appear to be the closest to the Indian mainland yet, and might be an indication of a possible extension of the breeding range of the noddy tern.

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8. RECORDS OF GREATER SPOTTED EAGLE (*AQUILA CLANGA*) FROM SOUTHERN INDIA

On a visit to the Vedanthangal Bird Sanctuary in the Chengai MGR dist., 80 km south of Chennai (=Madras), on February 14-15, 1996, we noticed two large raptors. They were larger than a kite, with short tail, thickset build and dark coloration. I could clearly see their white upper tail coverts and two rows of whitish spots on the wings which helped in their identification as greater spotted eagle (*Aquila clanga*). They were perched on trees within the tank, close to the nesting waterbirds. Each time they flew, they caused great commotion among the nesting birds, presumably as they posed a threat to the young ones.

From my past records, it appears this bird may be a rare winter visitor to Chennai. I have four sightings from the Guindy National Park [16.i.82; 13.xi.82; 28.xi.82 and 18.iii.90 (2 birds), once from Manali in North Chennai (30.i.83) and once at Vedanthangal on 23.iii.85. Besides, I have seen this bird twice at Kaliveli Tank near Pondicherry (31.i.88 and 29.x.88). My only other sighting of this species in southern India has been at Kogila Tank near Bangalore (2 birds) on 14.i.1990. Besides, Perennou (1989) has also reported this species from Kaliveli Tank in 1986-1987 and more recently Chandrasekhar (1996) has seen a bird at Vedanthangal in November, 1995.

Ali and Ripley (1983) mention that there are no recent records of this species from the Carnatic coast and the southernmost record is from Londa (N. Karnataka) by Koelz (1941). Over 100 years ago, Jerdon (1862) considered this species as "tolerably common in the Carnatic, and Malabar Coast, rare in the table land". However, the above records prove the species is still found in southern India, particularly in the Carnatic Coast, though it no longer appears to be common.

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9. UNUSUAL SIGHTING OF AN INDIAN BLACK CRESTED BAZA (*AVICEDA LEUPHOTES*)

This is to report the sighting and observation of an Indian black crested baza (*Aviceda leuphotes*) in a habitat not normally associated with it. The bird was observed on January 5, 1997 at 0830 hrs, in bright and clear weather, from the backwaters of Akkulam, a large brackish water lake, roughly 6 km northwest of Trivandrum city, within 1.5 km from the seacoast, 8° 31' 30" N, 77° 54' 23" S. This lake is overgrown with water hyacinth and other weeds and is highly polluted with the city's refuse. It is surrounded by coconut groves.

The bird was perched on a pole at a distance of 70 to 75 m from land, amidst dense water hyacinth and matted growth of mixed aquatic plants and grass, on water. The black

crest and distinguishing white breast with the dark border below were clearly visible. In flight, 2 to 3 white patches were noticed in the area of the secondaries, on both sides of the black rump.

The bird was solitary and feeding from the pole, it would glide into the weeds, land for a few seconds, pick up the prey and fly back to the pole with two or three lazy wingbeats. The whole action was highly reminiscent of an Indian roller. Eating of the prey could not be observed nor its identification made. The bird was observed for nearly half an hour. Other birds sharing the habitat were purple herons (*Ardea purpurea*) cormorants (*Phalacrocorax* sp.) whiskered terns (*Chlidonias hybrida*), pond herons (*Ardeola grayii*) eastern swallows (*Hirundo rustica*) and brahminy kites (*Haliastur indus*).

February 3, 1998

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10. ROOSTING BEHAVIOUR OF INDIAN PEAFOWL *PAVO CRISTATUS*

Roost site selection plays a pivotal role in the nesting success of any species. Judicious selection of the roosting site may enhance the survival of birds, by virtue of reduced heat loss, information sharing, accountability of population, and better protection from predators. (Tast and Rassi 1973, Gyllin *et al.* 1977, Gadgil and Ali 1975, Gadgil 1972).

The Indian peafowl (*Pavo cristatus*), a common bird in India, is known to roost in trees and large buildings at night. Though several papers have been written on the roosting behaviour of peafowl, detailed studies on roost site selection have only recently been carried out by Trivedi and Johnsingh (1996) in Gir forest.

On July 27, 1997, during our move to Sasan from Malanka village, near Madhuvanti dam on a 5 km stretch of road, we observed 28 electric poles of which 20 (71.42%) were occupied by Indian peafowl for roosting. To study the significance of this height as a preferable roost on the periphery of the Gir National Park, detailed observations were made on the birds roosting on the poles.

All the poles were examined carefully and the top part of each pole was categorised under 3 different roosting subsites i.e. (1) peak of the pole (2) top of the wire (3) three layers of horizontal bars. The number of peafowl occurring in each roosting site were recorded from 1915 to 2000 hrs till it became completely dark. On either side of the road there were a few crop fields and fallow land, but most of the area had forest cover.

Out of 16 poles used for roosting by 22 long trained (LT) birds, 13 (59.09%) roosted on top of the wire, 3 (13.64%) on the pole top and 6 (27.27%) over horizontal bars (Table 1). This top position of roosting was significantly preferred over horizontal bars ($X^2 = 8.08$, $P < 0.005$).

Out of total 45 short trained (ST) birds occupying 9 poles, 26 (57.77%) roosted on horizontal bars, whereas 17 (37.80%) roosted on wire and only 2 (4.44%) on pole peak (Table 1). This shows that there was no preference for horizontal bars ($X^2 = 1.08$, $0.25 < P < .50$).

Seven poles were occupied by a single LT bird exclusively, whereas on 6 poles one LT bird and other ST birds were recorded. On the other hand, on only two poles were 2 or more LT males roosting with ST birds.

Distribution of LT birds on a greater number of poles might be a behavioural adaptation to avoid predation risk. On the other hand, ST birds never roosted singly on a single pole. Furthermore, 4 poles were occupied only by ST birds.

Trivedi and Johnsingh (1996) have established that within the Gir National Park, peafowl preferred high trees. In view of their findings, we presume that all peafowl of the area should be roosting on the poles (the safest site in

TABLE 1
PEAFOWL COUNT ON ELECTRIC POLES

No. of Poles	Position occupied by long trained (LT) birds			Total	Position occupied by short trained (ST) birds			Total
	Pole peak	Wire	Horizontal bar		Pole peak	Wire	Horizontal bar	
8	01	06	05	12	02	10	19	31
7	02	04	01	07				
1	-	03	-	03				
4					-	07	07	14
20	03	13	06	22	02	17	26	45

view of the height). The leopard *Panthera pardus* is an important predator of peafowl in Gir forest (Trivedi and Johnsingh 1996). Preference for high trees for roosting was attributed to the danger from this ground predator, which can climb trees. Roosting on high tension electric poles is much safer, as leopards and other predators cannot climb on to them.

The data shows that long trained birds were more safety conscious than short trained ones, as they preferred wire against horizontal bars. For an LT bird it is extremely difficult to maintain a balance against high winds at heights of 50 m. During July, wind speed in this area ranges from 15-20 km/hr. To roost on wire rather than on the horizontal bars of the poles expends greater energy. Despite this, most of the LT peafowl preferred the wires indicating that predation pressure in the periphery of the sanctuary must be very high. The predation pressures on LT birds could be much more than on ST birds, as is reflected in site preference on the poles.

Further, this behaviour indicates adaptability of the species to a modified habitat. Such man-made structures, if installed within a sanctuary, would protect peafowl from predators like the leopard, which ultimately may have certain management implications. We do not know whether some peafowl were also roosting on the trees in the same area.

The observed roosting behaviour provides safety against predators but makes the peafowl vulnerable to local hunters known as 'Dafers', as birds on the pole are easy to shoot (P.P. Raval, pers. comm.). It seems that peafowl require protection from ground predators (not necessarily leopards) as we have seen them roosting on electric poles in some parts of Kheda dist. and also near Samakhiyali (Kachchh) on September 28, 1992 along with black ibises *Pseudibis papillosa*. Neither in Kheda nor in Kachchh does the leopard exist, yet these two species were roosting on poles. The advantage of a high roost site is obvious (Yom-Tov 1979).

On July 26, 1997, we saw peafowl roosting on khejri *Prosopis cineraria* within a cattle egret heronry along the state highway at Bagodara (Ahmedabad dist.). All roosting behaviour described (including pole roosting) were recorded from the road side where there is always vehicular traffic. It seems that in the selection of roosting sites, safety against predators is more important than the disturbance due to vehicular traffic.

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March 31, 1999

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11. SIGHTING OF THE INDIAN REDBREASTED PARAKEET AT ANDHERI

On the evening of December 7, 1997 at 1630 hrs, I was at the residence of a friend at Andheri (West) Mumbai, when I heard an unusual call among the calls of the rose ringed parakeet. On investigation, I found it to be a parakeet quite unlike any I had seen before. I watched the bird through my binoculars. With the help of a field guide, I was able to identify it as the male of the Indian redbreasted parakeet *Psittacula alexandri*.

The bird was perched on top of a tree along with three other males of the same type. I observed them for a total of 10 minutes, after which they flew away. I spotted them again at about 1730 hrs, flying about in the same region. They were moving in a group making loud calls. They flew independent of the rose ringed parakeets, though there were plenty of the latter in the region.

These must have been escaped caged birds.

January 5, 1998

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12. ALBINO MYNA (*ACRIDOTHERES TRISTIS*) NEAR VITA, IN MAHARASHTRA

Near Vita in Sangli dist., Maharashtra, I saw a nest of the common myna (*Acridotheres tristis*) with two eggs. Both eggs hatched, and one was a pure albino. Both the chicks were successfully raised. The beak and legs were yellow.

A number of insects were successfully devoured by the albino myna. After fledging, the entire family flew away to a neighbouring hill (Sulkai).

September 24, 1998

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13. BLYTH'S REED WARBLER *ACROCEPHALUS DUMETORUM* FEEDING ON NECTAR

During my field visit to Ponmudi in Trivandrum forest division of Kerala Western Ghats on February 8, 1996, I observed several species of birds, namely grey drongo *Dicrurus*

leucophaeus, common rosefinch *Carpodacus erythrinus* and Blyth's myna *Sturnus malabaricus blythii* feeding on nectar from the flowers of an *Erythrina indica* tree, which stood on the Merchinston Tea estate fence. Interestingly, on close observation, I saw a Blyth's reed warbler *Acrocephalus dumetorum* feeding on nectar in the same tree. As the bird dipped its beak inside the flowers for a relatively long time and raised it up to swallow, it is evident that it drank nectar. The insectivorous Blyth's reed warbler was observed to feed on *Salvadora persica* fruits at Point Calimere Wildlife and Bird Sanctuary (Balasubramanian, 1996). Ali and Ripley (1983), and Cramp (1992) mentioned only insects as the food of Blyth's reed warbler. It is interesting to note that nectar also forms a food of this species. Among the plant materials, seeds of Umbelliferae and Cruciferae and black berry *Rubus* were recorded as food (Cramp 1992).

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14. SHORT-TOED LARK *CALANDRELLA CINEREA* FEEDING ON PEARL MILLET *PENNISETUM TYPHOIDES* IN RAJASTHAN, INDIA.

Short-toed lark is a common and abundant winter visitor throughout the northwest desert and semi-desert portions of India (Ali and Ripley 1986). They are gregarious in winter, preferring to feed in bare fallow fields in relatively arid desert tracts, avoiding cropland (Roberts 1992).

On October 3, 1993 while surveying the avifauna of the Desert National Park, Rajasthan, near Barna village, just outside the boundary of the park, I saw a farmer driving away 'clouds' of short-toed lark *Calandrella cinerea* from his small field of pearl millet *Pennisetum typhoides* by beating a metal box. Apparently his efforts to drive away the birds were unsuccessful, as the birds were not leaving the field but merely settling some distance away from the farmer to resume their feeding activity. On closer investigation, unusual feeding behaviour was observed.

There were 7-8 large flocks of birds hovering near the pearl millet panicles. The average height of the millet plants was about 2 m. The birds were pecking at the panicles while flying/hovering to dislodge the grain. After each bout of pecking activity lasting 5-10 seconds, they would descend to the ground to feed on fallen grains. One or two birds were sitting on half bent stems to pluck grains from the panicles. Considerable damage was done to the panicles and a large number of fallen grains were found on the ground, due to the feeding activity of these birds.

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15. AN UNUSUAL NESTING SITE OF *NECTARINIA ASIATICA*

The nest of the purple sunbird *Nectarinia asiatica* is usually suspended on a twig and placed a metre or two from the ground, hanging under a bough or bush. Some unusual nest sites are also mentioned in the available literature.

On April 14, 1996, a nest of *Nectarinia asiatica* was noticed in Hanuman Nagar, Jaipur, suspended from an electric pole. It was about 8 m above the ground and fully exposed. Interestingly, in the vicinity of the nest there were many potential nesting sites. I am not sure why the electric pole was selected for nesting. The nest was complete when I discovered it and the pair was busy feeding the chicks. The pair was successful in raising the two chicks. A photograph was taken, but it is not of reproducible quality.

January 23, 1998

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16. REPTILES OF KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

The present paper is based on an inventory made in Keoladeo National Park (KNP), Bharatpur during 1986-90. The KNP (27° 7.6' to 27° 2.20' N and 77° 29.5' to 77° 33.9' E) lies in the Indo-Gangetic flood plains. Total area of this National Park is 29 sq. km, of which 8.5 sq. km is a seasonal wetland. The present report is significant as eastern Rajasthan was not adequately surveyed for reptiles in the past (Biswas and Sanyal 1977). Altogether, 29 species of reptiles, which represent 11 families and 24 genera (Table 1) were recorded during the present study.

Seven species of freshwater turtles consisting of four hardshells and three softshells were recorded from KNP (Table 1). The record of the Indian peacock softshell turtle is a range extension (Bhupathy and Ajithkumar 1988). Information on the ecology of Indian flapshell turtle in this National Park is available (Bhupathy and Vijayan 1993, 1994). Eight species of lizards including three species of geckos, two agamids, two skinks and one species of monitor lizard were recorded. Among them the Indian garden lizard and Bengal monitor lizard were common. Fan-throated lizard, a common species found elsewhere in Rajasthan was observed only twice outside KNP, and it may be found inside this National Park. Fourteen species of snakes were recorded, of which the Indian saw-scaled viper was observed once outside KNP. Indian rock python was the most common snake in the terrestrial, and checkered keelback water snake in the aquatic area. It was estimated that about 150 pythons inhabit KNP; information on some aspects of its general ecology is available elsewhere (Bhupathy and Vijayan 1989).

The number of reptile species found in KNP is high considering its size. This could be due to its strategic placement bordering dry semi-arid, and wet Gangetic flood plains. All seven species of turtles, recorded from the KNP are found in the Ganges system. It is to be noted that during the monsoon, KNP receives water from the River Gambhir, a tributary of River Yamuna. Species such as the Pakistan ribbon snake, Indian saw-scaled viper and fan-throated lizard are typical of arid regions. Absence of the Indian star tortoise *Geochelone elegans* in KNP may be due to wet conditions and inundation during the monsoon. High densities of the Indian rock python in KNP could be mainly due to the protection rendered by the Rajasthan Forest Department and abundant food.

ACKNOWLEDGEMENTS

The present research was a part of a collaborative project of the Bombay Natural

TABLE 1
REPTILES RECORDED IN KEOLADEO NATIONAL PARK DURING 1986-90.

Scientific name	Common name	Status
Family: Bataguridae (Hardshell turtles, pond turtles)		
1. *Geoclemys hamiltonii*	Spotted pond turtle	Uncommon
2 *Hardella thurjii*	Crowned river turtle	Common
3. *Kachuga tecta*	Indian roofed turtle	Uncommon
4. *K. tentoria*	Indian tent turtle	Rare
Family: Trionychidae (Softshell turtles)		
5. *Aspideretes gangeticus*	Indian softshell turtle	Common
6. *A. hurum*	Indian peacock softshell turtle	Uncommon
7. *Lissemys punctata*	Indian flapshell turtle	Common
Family: Gekkonidae (Geckos)		
8. *Hemidactylus brookii*	Brook's house gecko	Uncommon
9. *H. flaviviridis*	Yellow-green house gecko	Common
10. *H. triedrus*	Termite hill gecko	Rare?
Family: Agamidae (Garden lizards)		
11. *Calotes versicolor*	Indian garden lizard	Common
12. *Sitana ponticeriana*	Fan-throated lizard	Rare
Family: Scincidae (Skinks)		
13. *Lygosoma punctata*	Spotted supple skink	Uncommon
14. *Mabuya dissimilis*	Striped grass skink	Rare
Family: Varanidae (Monitor lizards)		
15. *Varanus bengalensis*	Bengal monitor	Common
Family: Typhlopidae (Worm snake)		
16. *Ramphotyphlops braminus*	Common worm snake	Uncommon
Family: Boidae (Earth snakes)		
17. *Eryx conicus*	Common sand boa	Rare
18. *E. johnii*	Red sand boa	Rare
19. *Python molurus*	Indian rock python	Common
Family: Colubridae		
20. *Boiga trigonatus*	Common Indian cat snake	Uncommon
21. *Lycodon aulicus*	Common wolf snake	Uncommon
22. *Oligodon armensis*	Banded kukri snake	Rare
23. *Psammophis leithii*	Pakistan ribbon snake	Rare
24. *Ptyas mucosus*	Western rat snake	Common
25. *Xenochrophis piscator*	Checkered keelback water snake	Common
Family: Elapidae		
26. *Bungarus caeruleus*	Common Indian krait	Rare?
27. *Naja naja*	Spectacled cobra	Common
Family: Viperidae (Vipers)		
28. *Daboia russelii*	Russell's viper	Rare
29. *Echis carinatus*	Indian saw-scaled viper	Rare

Sightings >25, 10≤25, and <10 were considered as common, uncommon and rare respectively; nomenclature follows Das (1997).

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17. A LARGE BROOD OF THE GREEN PIT VIPER (*TRIMERESURUS GRAMINEUS*)

A green pit viper (*Trimeresurus gramineus*) was caught on May 7, 1997, close to Nere village, Panvel, Navi Mumbai, at 2330 hrs. The snake was brought to the Indian Herpetological Society, Raigad branch. Upon closer observation and palpation, it was found to be gravid. It measured 105 cm (TBL) and was parrot green dorsally and yellow ventrally. The maximum recorded length for this species is 111.7 cm (Daniel 1983).

The snake was kept in a wooden cage measuring 0.9 m x 0.6 m x 0.6 m, with two netting windows for ventilation and glass on one side for observation. A potted plant kept in the cage was instantly accepted by the female. On approaching the cage, the female adopted a defensive posture and threw the forebody into a large 'S', resting the mid-body on the plant. Unusually rapid movements of the tail tip were observed, similar to snakes of *Boiga* species.

The following day the snake was presented with a house gecko (*Hemidactylus* sp.), which was not consumed. When the cage was checked on May 10, at about 0200 hrs, no neonates were seen. But at 0900 hrs on the same day, 20 neonates were observed in the cage. Since the literature (Daniel 1983, Mattison 1995, Khaire 1996) does not mention time taken for birth it would be relevant to state that all 20 young were born within 6-7 hours.

Post-birth membrane was present on 15 neonates. Of these 11 were bottle green dorsally, while nine were parrot green, with a yellow tinge. All had a prominent black streak on either side of the head, extending from the eye to the neck. Distinct, irregular, dark cross-bars were also visible on the dorsum of all neonates. The size ranged from 11-13 cm (TBL). All the young were healthy and active. The female was motionless, and rested for about three hours on the plant.

The house gecko introduced on May 8, 1999 was still alive in the cage. On May 10, three additional juvenile house geckos, two juvenile frogs (*Rana* sp.) and three juvenile toads (*Bufo* sp.) were introduced in the cage. All neonates sloughed three days after birth. One fed on a juvenile house gecko after moulting. No feeding was observed in the cage for the next three days. There is little information about the young of this species having fed in captivity (Barooa 1951, Kinnear 1912). On May 16, all neonates and the female were released in a forested tract near Panvel.

From the literature surveyed, the largest previously recorded brood consisted of 15 young (Kinnear 1912). This observation appears to be the largest brood size for the species.

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18. OBSERVATION ON THE REPRODUCTION OF *POLYPEDATES LEUCOMYSTAX* (GRAVENHORST 1829) (ANURA : RHACOPHORIDAE)

On June 6, 1998, at 1945 hrs, we spotted a pair of *Polypedates leucomystax* in amplexus inside a newly built tank (180 cm x 240 cm x 180 cm) with 150 cm deep rainwater. Five other males were also observed calling around the same tank. At 1951 hrs the female (SVL 60 mm) discharged a colourless gel and started to work her hindlimbs slowly in a sideways fanning motion from her ankles, touching the cloaca. At the same time the male (SVL 48 mm) too followed the female in moving its hindlimbs from the ankles, between the cloaca and ankles of the female. A white frothy mass was formed which adhered to the wall of the tank. After a few minutes, the female started discharging a few ova at a time into the foam at intervals of 10-20 seconds, the intervals increased to maximum one minute. Between intervals both male and female stopped moving their hindlimbs. Every time the female moved the hindlimbs, the male did the same. Finally, the foam reached a size of *c.* 6 x 7.5 cm.

As the female stopped laying eggs at 2030 hrs, the male withdrew its feet from the foam and slowly dismounted from the female. During the foam-nest construction the female kept her eyes closed only once at 2029 hrs and stopped moving her feet. She moved her hindlimbs only once after the male dismounted. At 2030 hrs, she sat 2 cm above the foam, withdrawing her feet, stood stationary for 5 minutes in the same position and jumped into the water at 2035 hrs, swimming to the far side of the tank. In the meanwhile, the foam covering became reddish-brown, the centre remaining white.

Just before ovulation, the pair was observed taking a dip in the water immersing up to two-thirds of their bodies. Then they climbed about 6 cm above the level of the water. The female held firmly on to the wall, taking the support of a dried remnant of old foam. The male held the female firmly under her shoulder. During ovulation, the femur of the female was at right angles to her body. Distinct pulsation was observed in her abdomen while discharging ova.

The event described was observed under a charge light. Although the observation was very close, the nearest was 25 cm, the pair was apparently not disturbed. In fact, the male jumped to the light source after dismounting.

The same tank had been used by 10 pairs of *Polypedates leucomystax*, including the observed pair, since April 11, 1998, within a period of 56 days.

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19. DISTRIBUTION OF *PANGIO GOAENSIS* (TILAK) CYPRINIFORMES : COBITIDAE, IN MANIMALA RIVER, SOUTHERN KERALA

(*With one text-figure*)

Loaches of the genus *Pangio* are considered to be good aquarium fishes due to their small size and vivid colour patterns. The range of distribution of *Pangio* is from Indonesia, through Vietnam, to India (Talwar & Jhingran, 1991). According to Easa and Basha (1995), the genus *Pangio* is represented in India by four species viz., *Pangio pangia* (Ham.), *P. longipennis* Menon, *P. goaensis* (Tilak) and *P. bashai* Easa and Shaji.

Tilak (1973) originally described *Pangio (Acanthophthalmus) goaensis* based on a single specimen collected from Colem river Goa. This species is commonly known as the Indian coolie-loach. Subsequently Rema Devi *et al.* (1996) reported this species from Chaliyar river, northern Kerala. Thus *Pangio goaensis* is so far known only from Goa and northern Kerala (north of the Palghat gap). According to Rema Devi (pers. comm.) this species is similar to *Pangio bashai* from Chaliyar river.

Recently 12 specimens (31 to 33 mm in total length) of this species were collected by us from Manimala river of southern Kerala (south of the Palghat gap). Specimens were collected from Mallapally (8 specimens) and Kottangal (4 specimens) areas of Pathanamthitta dist. Detritus, mud, sand and gravel are the main substrates in the collection sites, of which sand constituted about 65% of the total. Land use pattern is mainly rubber plantations with settlements.

Fig. 1: Lateral view of *Pangio goaensis* (Tilak)

Pangio goaensis can be easily distinguished from other species by its elongated and fairly compressed body and head. The dorsal fin is inserted in the posterior half of the body, between the pelvic and anal fins. Caudal fin truncate. Scales are very minute and are embedded in the skin; lateral line is absent. Three dark bands run from the tip to the base of the caudal fin, one is on the mid-dorsal line and the other two are on the sides of the body. The two outer bands end in a blotch at the base of the caudal fin. The median band is wider and darker than the others (Fig. 1).

The present record of this species from Manimala river is the first report from southern Kerala, extending its range of distribution to southern Kerala.

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20. RECORD OF THE BARB *BARBODUS CARNATICUS* (CYPRINIDAE : CYPRINIFORMES) FROM THE STREAMS OF EASTERN GHATS, OF TAMIL NADU.

The large barb *Barbodus carnaticus* is endemic to Western Ghats, being known only from the Cauvery drainages at the base of the Nilgiris, Wynaad and also from Karnataka (Talwar and Jhingran, 1991; Menon, 1992; Arunachalam *et al.*, 1998). It grows to a maximum size of about 60 cm in length and 12 kg in weight (Menon, 1992); in our ongoing Western Ghats biodiversity programme we recorded specimens from 25 cm to 40 cm in length (0.5-3 kg in weight). During a recent survey, we collected a fair number of specimens of *B. carnaticus* from an unnamed stream near Arapaleeswar temple, and also some unnamed streams in Kolli hills of Eastern Ghats, Tamil Nadu. The literature on Eastern Ghats (Talwar and Jhingran, 1991; Misra, 1938; Lazarus *et al.*, 1988; Rema Devi, 1992) shows that this species was not reported from this region by earlier workers. Till now, the distribution of the species was Cauvery drainage systems of Western Ghats (Molur and Walker, 1998). The present record shows its extension to Eastern Ghats, indicating affinities between Western Ghats and Eastern Ghats of Tamil Nadu.

DESCRIPTION

D IV/8; P 15; V 9; A II/5; C 19; Ltr. Scales 5, 3 ½. Body elongate, dorsal profile more convex than ventral; its depth 2.8 to 3.2 times in standard length. Head length 4.0 to 4.25 times in head. Mouth subterminal; lips moderately fleshy. Barbels two pairs, maxillary pair longer than rostral pair. Dorsal fin inserted midway between tip of snout and caudal base. Last undivided dorsal ray osseous, strong. Lateral line complete with 30-32 scales. Colour in live specimens dark olivaceous green on back, fading to dull white with gold on flanks and abdomen. After preservation in formaline, light brown on dorsal side and flanks, abdomen pale yellow.

Habitat and Ecology

B. carnaticus prefers large pools and riffle habitats of rapid rivers and streams. Adults prefer pools, hiding in undercutting of bedrock and boulders, while juveniles prefer riffle habitats. It feeds mostly on benthic substrates. It has been introduced into reservoirs of Periyar and Cauvery drainage systems.

Distribution

Found in Cauvery, Bhavani, Moyar rivers in Tamil Nadu; Periyar reservoir (introduced) in Kerala (Menon, 1992) and Hemavathi river of Karnataka (Arunachalam *et al.*, 1998). We collected this species for the first time from an unnamed stream near Arapaleeswar temple in Kolli hills of Eastern Ghats, Tamil Nadu.

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21. RANGE EXTENSION OF *OSTEOBRAMA COTIO PENINSULARIS* SILAS TO KERALA

The genus *Osteobrama* is found in the Oriental region and is restricted to Pakistan, India, Bangladesh, Myanmar and China (Talwar and Jhingran, 1991). This genus is characterised by having a dorsal fin inserted slightly behind pelvic fins with 11 or 12 rays (8 or 9 branched), a strong serrated spine and a long anal fin with 14-36 rays (11-13 branched). The present report of *Osteobrama cotio peninsularis* is based on two specimens collected from Periyar river, Central Kerala.

Osteobrama cotio peninsularis Silas

Distinguishing characters: D iii-iv 8-9; A iii 28-31; Pl 12-14; V i 9.

Body trapezoid and considerably compressed, its depth 2.2 to 2.9 times in standard length; abdominal edge trenchant from base of pelvic fins to anal fin, but rounded in front of pelvic fins. Mouth small; barbels absent. Dorsal spine weak and serrated. Scales small; lateral line with 55 to 60 scales; scale-rows 7½ to 9½ between lateral line and base of pelvic fins; predorsal scales 21-24.

Osteobrama cotio peninsularis can be easily identified from its closely related subspecies by the presence of fewer branched rays in the anal fin, less than 10½ scale-rows between lateral line and pelvic fin, greater number of lateral line scales and lesser number of pre-dorsal scales. It can be distinguished from *O. cotio cotio* in the lesser number of branched rays in the anal fin, less than 10½ scale-rows between lateral line and pelvic fin; and it can also be distinguished from *O. cotio cunma* by the presence of greater number of lateral line scales and fewer pre-dorsal scales.

Geographic distribution: Peninsular India: Maharashtra, Orissa, Andhra Pradesh and Kerala.

Remarks: The genus *Osteobrama* is represented by seven species in India, of which *O. bakeri* is endemic to Kerala. *O. bakeri* is the

only species reported so far from Kerala under this genus. Menon (1997) considers *O. bakeri* as rare in Kerala. Except *O. cotio peninsularis* the two other subspecies of *O. cotio* are commonly distributed in North India, while the former is only distributed in the rivers of peninsular India: Maharashtra, Orissa, Andhra Pradesh (Talwar and Jhingran, 1991). Type locality of *O. cotio peninsularis* is Pune. There was no authentic record on the occurrence of this species from the freshwaters of Kerala. While conducting a survey in Periyar river in central Kerala, we collected the species from Aluva region. The species is very rare in the collections, as only two specimens were obtained along with some other *Puntius* spp. The present report thus extends its distribution to the rivers of Kerala.

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We are thankful to Dr. K. Rema Devi, Scientist, Zoological Survey of India, Southern Regional Station, Chennai for confirming our identification of the species.

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22. *MYSTUS BLEEKERI* (DAY) — AN ADDITION TO THE FISH FAUNA OF KERALA

Bleeker (1846) originally described *Bagrus keletius* (*Mystus bleekeri*) from Bengal. In 1877 Day modified the taxon as *Macrones bleekeri* (Talwar & Jhingran, 1991). It is characterised by a depressed head and an elongate, compressed body. Barbels four pairs, the maxillary barbels extend posteriorly to the anal fin. A large adipose fin is present. Body colour in life is brownish above and lighter below. Two longitudinal bands present above and below the lateral line. There is also a dark shoulder spot on either side below the lateral line.

Mystus bleekeri is generally confined to northern India and, according to Hora (1940), the southernmost limit is the Mahanadi headwaters. It inhabits lakes, tanks and rivers. There has been no report of this species from Kerala. While conducting a survey on the distribution of freshwater fishes in Neyyar River, we collected two specimens of *Mystus bleekeri* (of 5.4 and 6.0 cm total length) from Ottasekaramangalam thodu in Thiruvananthapuram dist. The collection site has a mixed substrate of detritus, mud, sand, cobble and bedrock, sand being the most dominant.

The diagnostic characters are the same as those given in the original description, except for some minor differences.

D. 1/7-8, P. 1/9-10, A. 9-10, C. 17

The present record extends the range of distribution of the species to Kerala.

ACKNOWLEDGEMENTS

We thank Dr. K. Rema Devi, Scientist, Z.S.I. Southern Regional Station, Chennai, for confirming the identification of our species. We also thank the Kerala Forest Department for their

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23. SEASONAL ABUNDANCE AND CHECKLIST OF AQUATIC BUGS AND BEETLES OF KEOLADEO NATIONAL PARK, BHARATPUR, INDIA

(*With two text-figures*)

The Keoladeo National Park, Bharatpur is known for the large congregation of waterfowl and other aquatic birds which feed mainly on aquatic insects and fishes (Ali and Vijayan, 1983). Even though some preliminary studies were carried out on the aquatic insect fauna of the Park (Mahajan *et al.*, 1982), a complete and authentic checklist is not available. Most of the insects were identified up to family level. (Ali and Vijayan 1986, and Vijayan 1991). The present report covers the

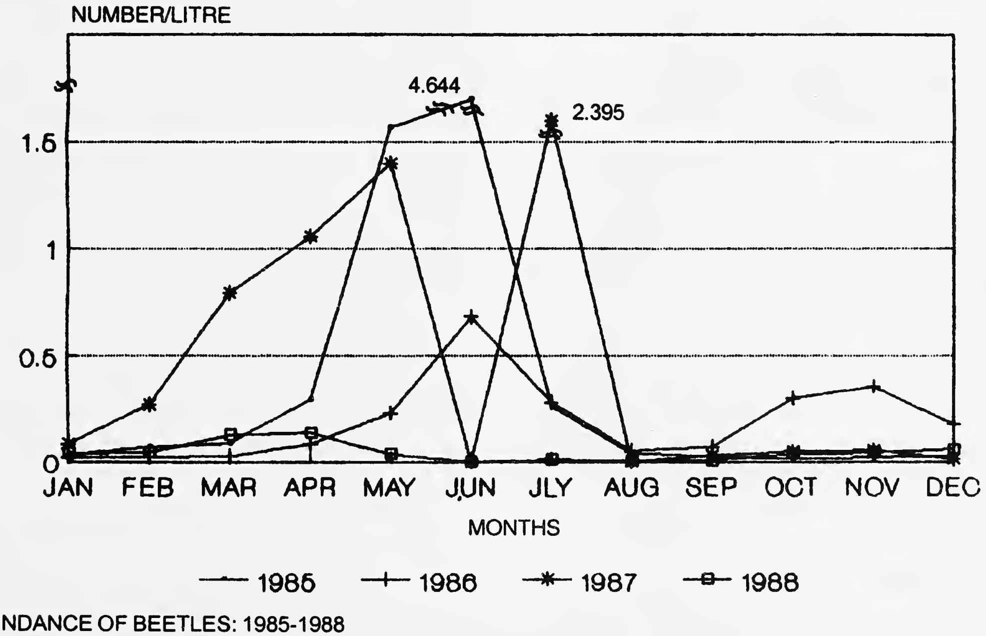

Fig. 1: Average number of beetles collected from Keoladeo National Park

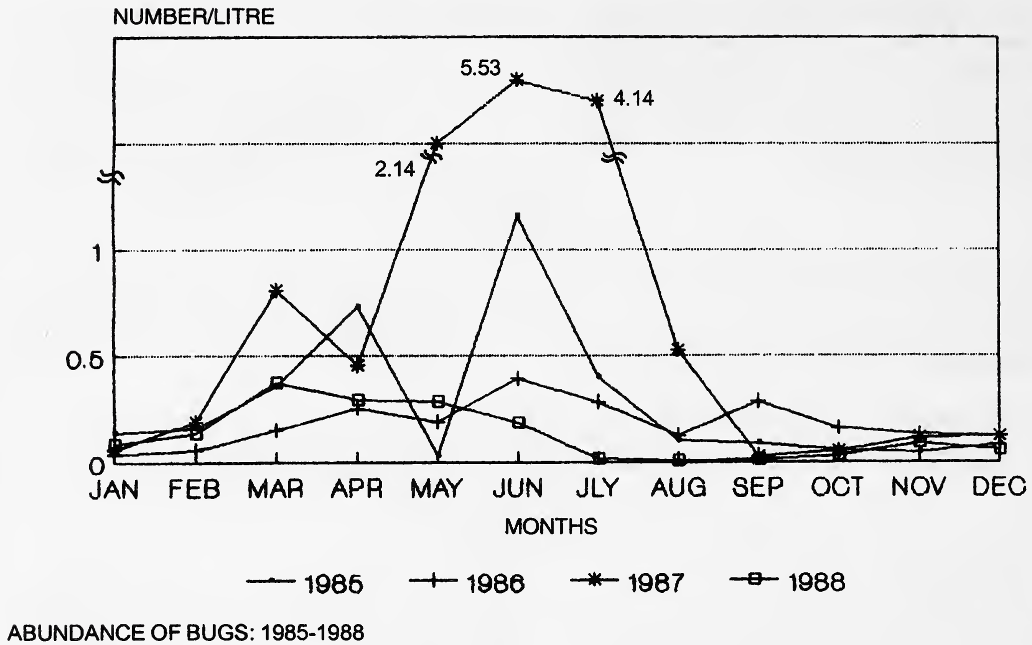

Fig. 2: Average number of bugs collected from Keoladeo National Park

seasonal abundance and list of aquatic bugs and beetles from Keoladeo National Park, Bharatpur, (KNP) collected during 1985-1988.

Study area and Methodology: Keoladeo National Park, Bharatpur (27° 7.6' to 27° 12.2' N and 77° 29.5' to 77° 33.9' E) is situated 50 km west of Agra and 180 km south of New Delhi. The total area of the park is 29 sq. km, of which 8.5 sq. km is wetland. The water depth in the aquatic area varies from 0-200 cm. The water inside the park is drawn during monsoon every year through a canal from Ajan bund, an inundation reservoir situated half a kilometre south of KNP. The Park dries up in May-June, leaving some pools in the deeper area. Insects were collected fortnightly between 0600 hrs and 1000 hrs from 23 stations, using an insect sampler as described by Ali and Vijayan (1983).

Seasonal Abundance: The total number of insects collected per litre of water were recorded. The average number of insects collected during each month is summarised in Figs. 1 and 2. The general trend in population fluctuation of beetles and bugs showed almost the same pattern. They were more numerous during the summer when the water availability in KNP was less. Their numbers were minimum during the winter and the monsoon, when the availability of water was more. However, the species composition showed wide fluctuations during different seasons within a year and between the years. A significant negative correlation was noticed with water depth ($r = -0.713$, $p < 0.001$). The availability of insects in the park showed a significant negative relation with water depth and dissolved oxygen. Both CO_2 and Methyl orange alkalinity showed a significant positive relation (Vijayan, 1991).

During summer, the aquatic area of the park dries up, leaving small puddles. The peak in the availability of insects during summer was mainly due to their aggregation in these puddles. Smaller species like *Canthydrus laetabilis* and *Plea* sp. survived in the puddles in large numbers.

TABLE 1
BUGS AND BEETLES RECORDED IN THE PARK

Bugs	
Order: Hemiptera	Abundance
Family: Belostomatidae	
Lithocerus indicus	**
Sphaerodema molestum (Dufour)	*
Sphaerodema annulatum Fabricius	*
Sphaerodema rusticum Fabricius	*
Family: Corixidae	
Micronecta scutellaris (Stal)	*
Corixa hieroglyphica Dufour	*
Family: Notonectidae	
Anisops cavifrons Brooks.	*
Family: Nepidae	
Nepa cinerea	***
Ranatra sordidula Dohrn	**
Family: Gerridae	
Gerris spinolae	*
Family: Pleidae	
Plea sp.	*
Beetles	
Order: Coleoptera	Abundance
Family: Dytiscidae	
Hyphoporus elevatus Sharp	**
Cybister limbatus Fab	***
Laccophilus parvulus Aube	**
Eretes sticticus L.	**
Canthydrus laetabilis Walke	*
Family: Hydrophilidae	
Amphiops simplex Sharp.	**
Amphiops sp. nr. *mater* Sharp	**
Berosus indicus Motschulsky	**
Family: Gyrinidae	
Dineutus unidentatus Aube	**

(Note: * = Common, ** = Not common and *** = Rare)

Larger species left the puddles for crevices in the mud, and also beneath the dry thick vegetation in the aquatic area.

One of the factors determining the abundance of insects was recruitment from outside the Park (Ajan bund) during monsoon. *Gerris spinolae*, *Anisops cavifrons*, *Cybister limbatus* larvae were collected along with the water from Ajan bund. Another factor determining insects in the Park appears to be related to the fluctuations in the biomass of aquatic macrophytes. The peak in the availability of aquatic insects seemed to be associated with the aquatic plants (Vijayan, 1991). Similar association was also reported by Tonapi and Ozarkar (1969) and Roy (1982).

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24. CONGREGATION OF COMMON CROW *EUPLOEA CORE* BUTTERFLIES AT BANNERGHATTA NATIONAL PARK

Some adult danaids like *Danaus limniace, D. chrysippus,* and *Euploea core* have been observed to feed on *Heliotropium indicum* (Amladi, 1975) and *Crotalaria retusa* (Chaturvedi & Satheesan, 1979) to acquire pyrrolizidine alkaloids contained in them. *Trichodesma* (Chaturvedi, 1994) and *Paracaryum coelestinum* (Haribal, 1992) were subsequently added to this list.

In Bannerghatta National Park, 25 km from Bangalore city, *Lantana camara* and *Chromolaena odorata* grow profusely in many parts of the park. These plants were cleared along the main road leading into the park, both by cutting down branches and by uprooting them and leaving them along the roadside.

I visited the National Park twice, on August 23 and August 30, 1998, and on both occasions it had rained the previous evening and through the night.

On both days many Common Crow *Euploea core* butterflies were noticed congregating only on dry roots of *Chromolaena odorata* and not on those of Lantana. However, none of the other Danaids were seen doing so, though the Striped Tiger *Danaus genutia* and the Dark Blue Tiger *D. melissa* were seen in the area (except possibly for the Double-banded Crow *Euploea coreta,* a forewing of which was found in the vicinity).

In the past, I have noticed many danaids visiting *Heliotropium* spp. and *Crotalaria*. It is for the first time that I have seen a congregation of Common Crow on the exposed roots of *Chromolena odorata*.

Is it possible that *Euploea core* acquire some alkaloids from the roots of *Chromolaena odorata* like they do by visiting *Heliotropium indicum* and other plants?

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Editor's note: The author's assumption is correct. Males of many danaine butterflies including members of *Euploea* are strongly attracted to withered or damaged plants of Asteraceae, to which they apply fluid by means of their proboscids and reimbibe it with dissolved pyrrolizidine (PAs). These PAs in danaine butterflies serve a dual function: as male pheromone precursors and as protective chemicals. It has also been reported that females are also attracted to PA plants and PAs have been observed in females of several danaines. It may be useful to census the sex of adults of *Euploea core* aggregating in *Chromalaena odorata* to find out if females are also attracted to the damaged plants, for females are supposed to gather PAs from nectar of flowers of Asteraceae and Boraginaceae.

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25. DISTRIBUTION AND ECOLOGY OF *POLYURA AGRARIA* SWINHOE (LEPIDOPTERA : NYMPHALIDAE) IN INDIA

The taxon *Polyura agraria* Swinhoe was treated as a form of *Polyura athamas* Drury until its elevation to species rank by Smiles (1982). Evans (1932) treated it as *Polyura athamas agrarius* Swinhoe from south India, while the north Indian population of *agraria* was placed under *athamas athamas,* with the qualification that it was very variable. Subsequent authors also followed this arrangement.

P. agraria can be distinguished from *P. athamas* by the more acute apex of the forewing, the broader pale area and the two sub-apical pale spots on the forewing. Larsen (1987) notes that *agraria* is smaller and paler than *athamas.* While it may appear paler due to the broader pale area, males of *agraria* may be marginally smaller than the average *athamas,* but many small *athamas* are smaller than *agraria.* Larsen (*op. cit.*) also notes that in some areas, it is more difficult to separate the two than in the Nilgiris.

As a result of the taxonomic confusion, there is not much information available on the distribution, habits and habitat preferences of *P. agraria.* According to D'Abrera (1985), the global distribution of *agraria* is over most of the Oriental Region, to Java, Sulawesi and the Flores and that of *athamas*, also over most of the Oriental Region, from India to the Philippines and Java.

Within India, *agraria* is known from the Western Ghats southwards from Maharashtra (Gaonkar, 1996), the Nilgiri Hills (Larsen, 1987), the Nagari Hills of the Eastern Ghats north of Chennai (Madras) (Alan Sharman, *in litt.*), Kulu (Smiles, *op. cit.*) and from Kumaon in the Himalaya (*pers. obs.*). Its appearance in the last two localities, together with its extralimital distribution, can be interpreted to mean that this insect also occurs in Nepal, the eastern Himalaya and northeast India, though there do not seem to be any records so far. Given its resemblance to *athamas* and the confusion of the past, this is not surprising and there is every likelihood that a thorough investigation will reveal the presence of this butterfly. Larsen's observation that these two species are more difficult to separate in some areas might have special reference to the eastern Himalaya.

Polyura athamas, which seems to be sympatric, is also found in Gujarat (Gaonkar *op. cit.*) and in Sri Lanka, where *agraria* has not been found so far. In the Himalaya, both *athamas* and *agraria* have been recorded as far west as Kulu in Himachal Pradesh.

Larsen (*op. cit.*) notes that *agraria* seems to be rare in the Nilgiris, even at low elevation. He obtained only three of them out of well over a hundred *athamas* sightings. The three *agraria* were recorded from Kallar, at 457 m above msl. The Nagari Hills north of Chennai, where *agraria* was also recorded, do not rise above 1000 m elevation.

In Kumaon, it appears to be well established in the Terai, around 450 m above msl where I have recorded it in October. There are two records from 1500 m near Bhimtal in Nainital dist. where it is a rare straggler. Both the records are from April in different years. Therefore, it seems to be bivoltine in northern India.

P. athamas seems to have a wider altitudinal distribution. It is found from low elevation to 1900 m in the hills of south India and up to 2700 m above msl in the Himalaya (Wynter-Blyth, 1957). *P. athamas* is as common up to 1500 m above msl as it is in lower hills while *agraria* does not seem to be established in the hills.

It follows that although *athamas* is known to breed in the hills, where I have recorded it in April and from June to October *agraria* does not, given its scarcity at 1500 m above msl and the tattered condition of the two specimens recorded,

further prove that they are merely stragglers from lower elevations.

Wynter-Blyth (*op. cit.*) records eleven confirmed larval host plants of *athamas,* all belonging to Leguminosae. Given the recent distinction of *agraria,* it must be clarified whether both species feed on the same plants or whether some of the eleven recorded host plants are exclusively fed upon by either species.

Both species evidently like warm areas in regions of heavy rainfall, with *athamas* also colonising regions of moderate rainfall such as Gujarat. *P. agraria* seems to be essentially a low elevation species, while *athamas* is more flexible. Both species have been recorded at over-ripe fruit and faeces (*pers. obs.*) and there is every likelihood that *agraria* will also be attracted to other decomposing substances favoured by the genera *Charaxes* Ochsenheimer and *Polyura* Billberg, including *P. athamas.* Wet sand will probably prove an attractant, as it is to other members of the genus.

Other behaviour of *agraria* seems to be the same as *athamas*, e.g. aggressive territoriality in males, rapid flight, and the fondness for basking on prominent perches.

Larsen (*op. cit.*) proposes the trivial name Anomalous Common Nawab for *P. agraria.* Given its relative scarcity, the 'Common' is misleading, so it would be best to drop it leaving 'Anomalous Nawab'. It seems the 'Common' was retained to imply its close relation with the Common Nawab *P. athamas,* but this relationship is in any case so obvious that it hardly requires to be included in the trivial name.

In conclusion, I would like to point out that although *P. agraria* appears to be scarce in certain localities, the main reason that so little is known about it is that it has been overlooked among the commoner *P. athamas.* It is not in any sense 'threatened', 'endangered' or on the verge of extinction.

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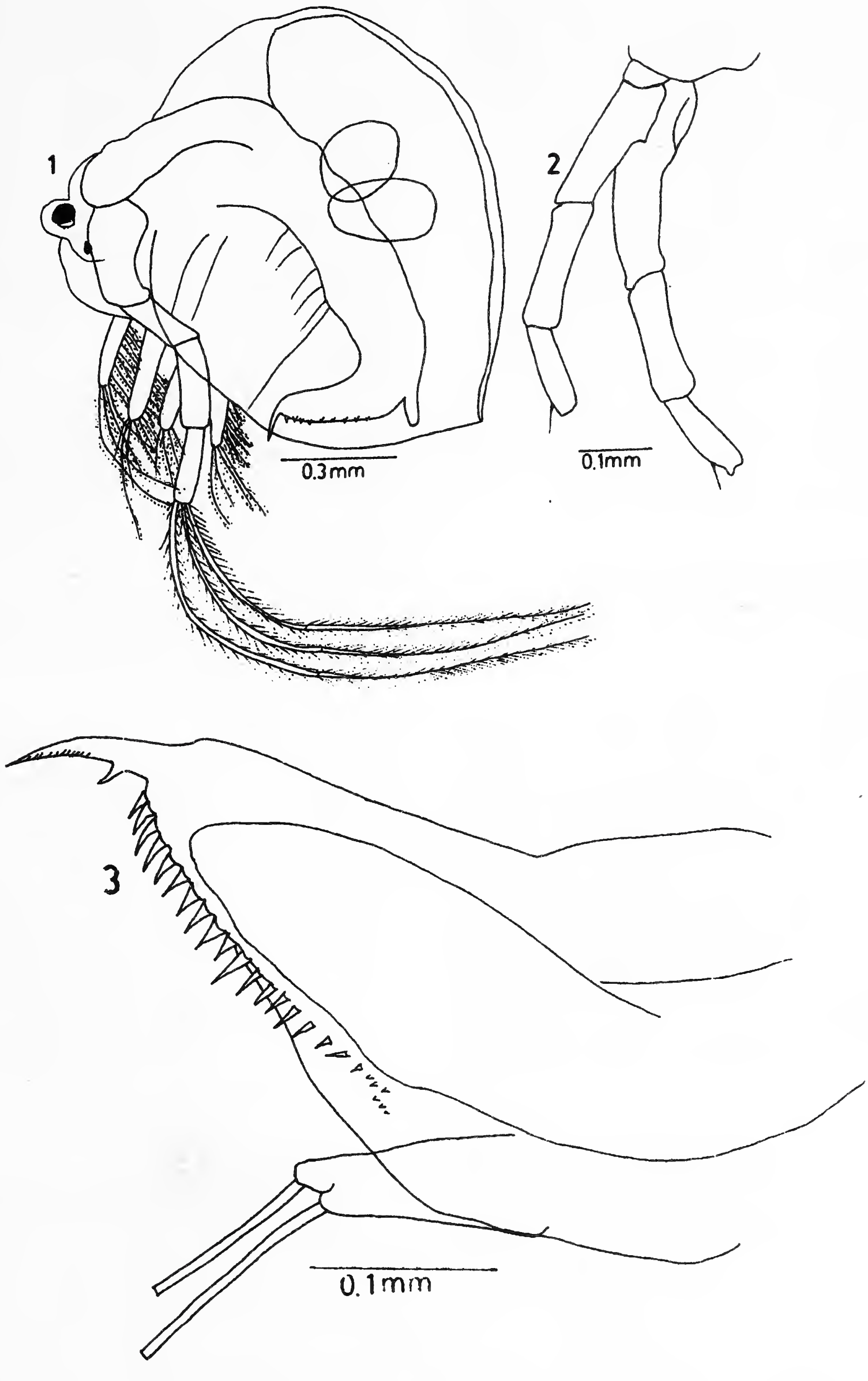
26. NEW RECORD OF AN ARCTIC SPECIES *HOLOPEDIUM GIBBERUM* ZADDACH (CRUSTACEA : CLADOCERA) FROM CHHANGU LAKE, SIKKIM

(*With three text-figures*)

The family Holopedidae is so far known to occur only in the mountain lakes of Europe and North America. From this family only two species, *Holopedium gibberum* and *H. amazonicum* have been recorded so far. The occurrence of *Holopedium gibberum* Zaddach in



Figs. 1-3: *Holopedium gibberum,* female: 1. lateral view; 2. antenna; 3. postabdomen.

the lakes of Sikkim is a new record for Asia.

A survey of zooplankton was conducted by one of us (BNR) in Chhangu lake, East Sikkim from July 1993 to July 1995. Collections were made at frequent intervals and the water and plankton samples were analysed for physico-chemical parameters and zooplankton biodiversity. The present species was collected from Chhangu lake, 38 km from Gangtok, East Sikkim. The size of the lake is 91,393.5 sq.m, at an altitude of 3,779 m above msl. The physico-chemical parameters of the lake water are as follows: pH 6.1-6.8; dissolved oxygen 3.75-8.6 mg/l; calcium 0.802-2.204 mg/l; sodium 0.007-0.022 mg/1; potassium 0.006-0.22 mg/1; nitrate 0.467-1.375 μg/1; phosphate 0.13-1.180 mg/1 and total solids 32.592-116.875 mg/1.

Holopedium gibberum Zaddach 1855

Material Examined: Seven females from Chhangu lake, May 1995, coll. B.N. Roy, East Sikkim.

Female: Body size 1.247±0.03 mm (without gelatinous mantle). Ventral margin of valves with fine spines. Six pairs of foliaceous legs. Head small, enclosing a small compound eye (Fig. 1). Antennule small, situated ventrally. Rostrum absent. Antennae long, biramous and almost twice the size of the body (Fig. 2). Postabdomen elongated and tapering, anal spines numerous, up to 20 (Fig. 3). Claws setulated along the concave surface with one basal spine.

Remarks: The species of the genus *Holopedium* are enclosed in a large gelatinous mantle, which is shed during ecdysis but regenerated within two hours (Hamilton, 1958). They are known to swim ventral side up, an adaptation mainly necessary to trap the suspended organic matter present in the water column. *H. gibberum* has been found by other workers mostly in waters with not more than 20 and often less than 10 mg/l calcium^{++} (Hamilton, 1958; Thienemann, 1926; Smyly, 1968) and this is also found true in the present study where the calcium levels of the lake water were very low (2.204 mg/1).

Michael and Sharma (1988) have reported eight families from India. The present study adds one more family and the total number of families of Cladocera of India now increases to nine. Except for China (nine families), all the neighbouring countries of India have only six families each.

We thank the Director, ZSI, Calcutta and the Officer-in-charge, MBS, ZSI, Chennai for the facilities provided.

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27. NEW RECORD OF A PATELLID GASTROPOD *AMATHINA TRICARINATA* (LINN.) (GASTROPODA : AMATHINIDAE) FROM THE COASTAL WATERS OF DIGHA, WEST BENGAL

During a study of marine invertebrates from the coastal waters of Digha, we collected a single specimen of *Amathina tricarinata* (Linn.) from the outer surface of a living pearl oyster shell.

In their account of molluscan fauna of West Bengal, Subba Rao *et al.* (1992) do not mention this patellid gastropod from this area. A brief description of the species is given below.

Family: Amathinidae

Amathina tricarinata (Linnaeus)

1767. *Patella tricarinata* Linnaeus., Syst. Nat. (ed 12): 1250.

Diagnostic characters: Shell solid, dull, roughly oval in outline, narrower posteriorly; protoconch heterostrophic; apex with 3 strong, rounded and occasionally scaly ribs radiating to the anterior edge where they project slightly; low, wavy, axial ribs occupy posterior slope.

Colour: Pale yellow.

Morphometric measurements: Length: 20 mm, diameter: 15 mm, height: 6 mm.

Distribution: INDIA: Andaman & Nicobar Islands, Orissa, Tamil Nadu. Digha (West Bengal) is now a new locality of the species. Elsewhere: Persian Gulf, Gulf of Oman.

Material examined: 1 ex. Digha mohana; coll. J. Sarkar & S. Talukdar, 17.ii.97, Regn. No. 1892.

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28. A NEW SITE RECORD FOR *RAPANA BULBOSA* (DILLWYN)

During a survey of molluscan fauna along the Alibag coast (Raigad dist., Maharashtra), I collected a specimen of *Rapana bulbosa.* Initially I thought it was an accidental occurrence, but during subsequent visits I have observed more live specimens on the same beach which confirm the occurrence.

Locality: Sasvane (Alibag, Maharashtra).

Description: Size 75 mm, large, thick and heavy shell. Shape globose. Spires low and grooved. Surface finely striated with weakly developed or blunt spines. Siphonal canal very short.

Colour: Chestnut.

Habitat: Sandy or rocky shore, also in coral sand in mesolittoral zone.

Distribution: The species has been previously reported from both the west and east coast but there are no records of the species from Maharashtra in the available

literature. It is also recorded from Philippines, Japan, China, Persian Gulf, Aden, Pakistan, Sri Lanka and Hong Kong.

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29. *FICUS SUPERBA* MIQ. AND *F. FERGUSONI* (KING) WORTHINGTON (MORACEAE), TWO NEW REPORTS FROM INDIA

(*With two text-figures*)

Ficus (Moraceae) is one of the largest plant genera of the tropics which enjoys a cosmopolitan distribution. It includes an estimated 900-950 species (750 known) in 4 subgenera viz. *Urostigma* (Gasp.) Miq. *Pharmacosycea* Miq., *Sycomorus* (Gasp.) Miq and *Ficus* (Corner, 1965). India has a *Ficus* flora of 59 spp. (Corner, 1967). Two more species, *Ficus superba* Miq. and *F. fergusoni* (King) Worthington belonging to the subgenus *Urostigma* are now reported from India.

Ficus superba Miq., Ann. Mus. Lugd. Bot. iii - 287, 1867. Pl. Jungh. 46; fl. Ind. Bot. I, pt. 2 - 334. (Fig. 1).

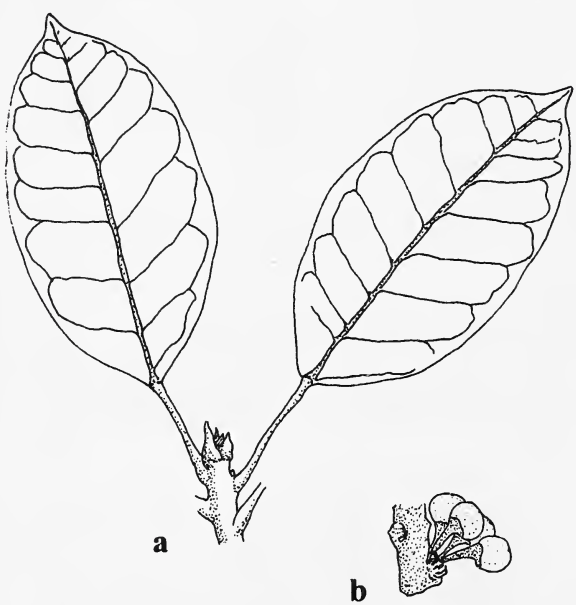

Fig. 1: *Ficus superba* Miq., a. leafy twigs b. cluster of figs

Large glabrous stranglers, without aerial roots, up to a height of *ca* 20-25 m.; leaves in alternate helix, towards the tip of 0.5-0.7 cm wide twigs; stipules short, blunt, villous and caducous; petiole 5-9 cm long, always longer than the width of the lamina; lamina elliptic, acutely acuminate at apex, acumen 0.8-1 cm long, obtuse at base, 10-25 x 5.8 cm, dark green, glabrous, slightly coriaceous, entire, slightly undulating on the margin, 3 ribbed at the base, 8-10 pairs of lateral, slender, prominent nerves, middle ones at an angle of 60-80° to the midrib, brochidodromous, tertiaries percurrent, forked and convex. Figs in cauliflorous clusters of 2-6 (Fig. 1b), usually produced on short, perennial tubercles (small lateral shoots) borne on the older twigs well below the node, pedunculate, peduncle 0.5-1.0 cm, globose, 1.0-1.2 cm when ripe, green with pale spots in early stages, creamy white with pink spots in phase D and turning purple and becoming succulent in phase E; basal bracts 3, triangular and deciduous; male flowers ostiolar, sessile, monandrous, with double anther sacs and perianth of 3 tepals fused at the base.

Status: Indigenous, rare.

Distribution: Japan, China, Southeast Asia to Australia.

Exsiccates: HZDC (Herbarium, Dept. of Zoology, University of Calicut) - I/1, Kerala, Palghat, Shornur, coll. DRP. 6.ii.1991; HZDC - I/2, Kerala, Wynaad, Vaithiri, coll. DRP. 7.v.1991; HZDC - I/3, Kerala, University of Calicut, coll. DRP. 8.iii.1993.

F. fergusoni (King) Worthington, Ceylon trees f. 407. 1959; Corner, Gard. Bull. Singapore 21: 14. 1968.

Ficus altissima Blume var. *fergusoni* King. Ann. R. Bot. Gard. Calcutta 1: 31, pl. 31, 1887; Trimen, Hand b. Fl. Ceylon 4 : 87, 1898. (Fig. 2).

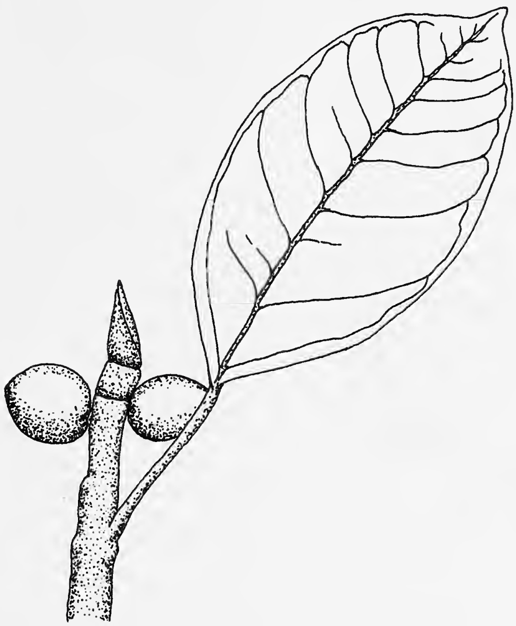

Fig. 2: *Ficus fergusoni* (King) Worthington; leafy twig with figs

Large, spreading, glabrous tree with many aerial roots. Leaves in helix on 0.5-0.8 cm wide twigs; stipulate lanceolate, acuminate, 1.5-2 cm long; petiole stout, 3-5 cm long; lamina thickly coriaceous, elongate - elliptic, acuminate at apex, obtuse at base, 8-18 x 6-9 cm, entire, 3 ribbed at base with 8-10 pairs of lateral nerves, those towards the middle at an angle of 50-70° to the midrib, anastomosing submarginally. Figs sessile, paired in the leaf axils towards the tip, ellipsoid, 15-20 cm long, early stages not enveloped in calypteriform bracts, pale green in phase A-C, reddish yellow in phase D and orange red in phase E; male flowers dispersed, pedicellate, perianth of 4 tepals; gall and female flowers with gamophyllous perianth.

Status: Naturalised (?), rare

Distribution: endemic to Sri Lanka.

Exsiccate: HZDC - III/1 Kerala, Trivandrum, Ponmudi, coll. DRP, 9.x.1990.

Note: This is the first report of this species outside Sri Lanka.

ACKNOWLEDGEMENTS

I thank Dr. C.C. Berg, Norwegian Arboretum, Store Milde, Norway, for help in identifying the specimens; Prof. N. Ravi, Scientist Emeritus, TBG & RI, Thiruvananthapuram, Kerala, for kindly reviewing the manuscript and Prof. U.C. Abdurahiman, Department of Zoology, University of Calicut, Kerala, for constant encouragement. I also thank University of Calicut, Kerala for financial assistance.

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30. *CASSINE BALAE* KOSTERM. — NEW TO THE CELASTRACEAE OF INDIA

(*With a text-figure*)

Cassine balae, described as a new species from Ceylon by Kostermans (1986) based on material which was earlier retained as a part of *Elaeodendron glaucum* (Rottb.) Pers. (= *Cassine*

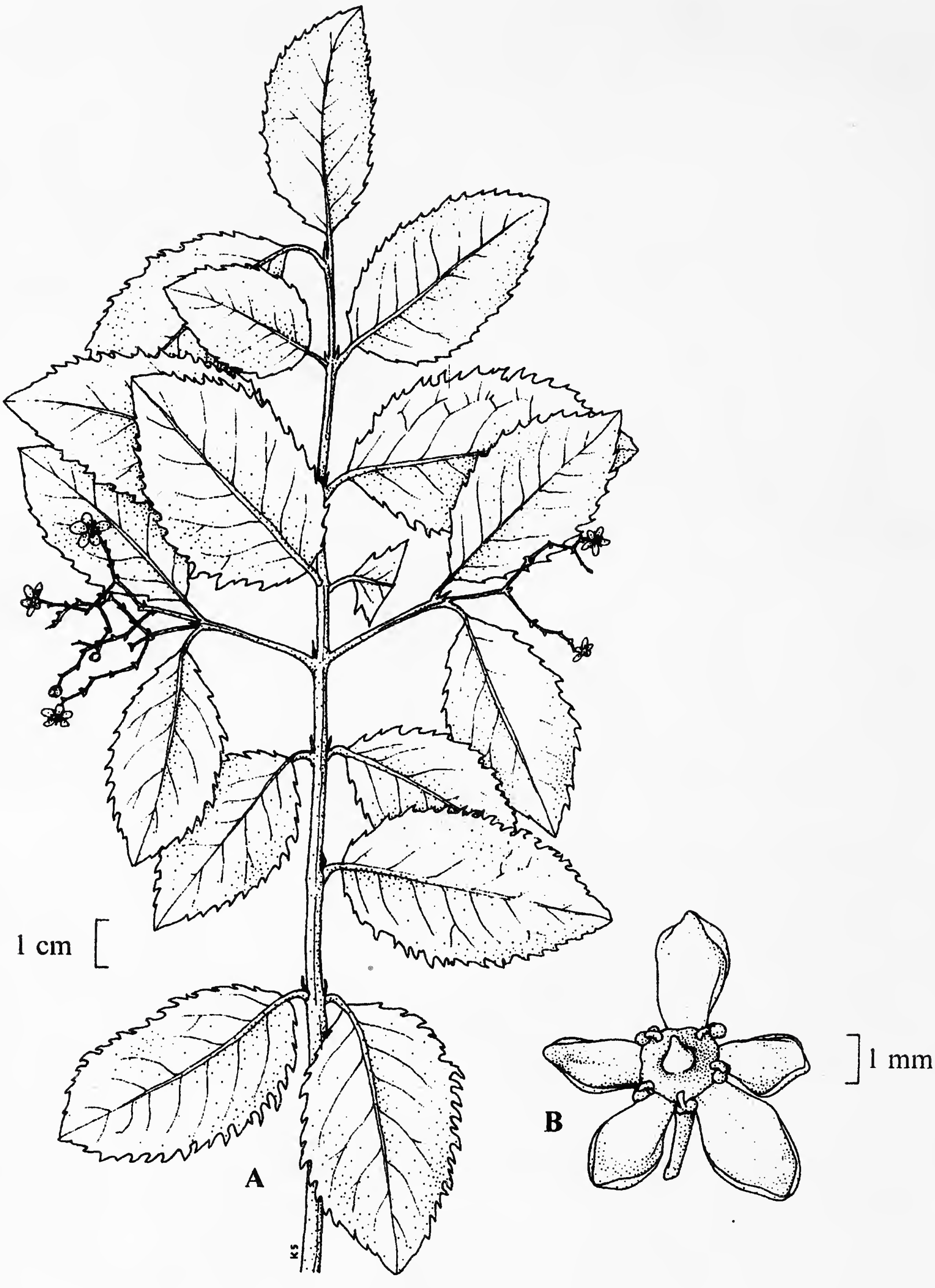

Fig. 1: *Cassine balae* Kosterm: A. Twig; B. Flower.

glauca (Rottb.) Kuntze (*vide* nomenclatural citations; also *vide* Kostermans 1986: 181-185) and reportedly endemic to Sri Lanka is added to the Indian flora from the Gulf of Mannar coast in Tamil Nadu. The interpolation of Roxb., Pl. Coromandel 2: 2. 1799, after the misapplied name *Cassine glauca* by Kostermans (1986) in the nomenclatural citations, however, is inadvertent. As an explanation for the asterisk at *Schrebera swietenioides* in the footnote, Roxburgh (1799) *inter alia* stated that *Schrebera albens* Retz. (*Celastrus glaucus* Vahl) is a species of *Elaeodendrum,* which does not constitute valid publication of the combination (Art. 33.1).

A detailed description is provided as also an illustration. Notes are added on the phenology, habitat, probable route of entry among others.

Cassine balae Kosterm. *In* Gard. Bull. Singapore 39: 185. 1986. – Type: Sri Lanka Habantotta, along the coast, Sept., fr., Coll. Balasubramaniam 2213 (AAU, K, L holotype). Trincomalee, Jan. 1940, Coll. T.B. Worthington 742 (PDA paratype, photocopy!).

Elaeodendron glaucum auct. non (Rottb.) Pers. 1805: Roxb., Fl. Ind. 2: 639. 1832, excl. syns. *Mangifera glauca* Rottb. 1783, *Celastrus glaucus* (Rottb.) Vahl 1791 & *Schrebera albens* Retz. 1791 (as '*Elaeodendrum*'); Voigt, Hort, Suburb. Calcut. 167. 1845, p.p., quoad cit. Ceylon; Lawson in Hook. f., Fl. Brit. India 1: 623. 1875, p.p., quoad cit. Ceylon; Trimen, Handb. Fl. Ceylon 1: 271. 1893, p.p.

Bushy shrub, *c* 1.5 m high, glabrous; branches many, slender; bark furrowed. Leaves simple, opposite, ovate or elliptic-oblong, cuneate at base, deeply serrate with pungent serrations along margins, acute or obtuse-subacute at apex, 3-7 x 1.5-4 cm, coriaceous, glabrous, dark green; lateral nerves 5-7 (up to 9) on each side, prominent; petioles 0.4-1 cm long, glossy; stipules minute, scaly. Panicles axillary, loose, *c.* 4 x 4 cm; cymes dichotomous, few-flowered; peduncles slender, 1-2 cm long; bracts and bracteoles minute, subulate; pedicles filiform, *c.* 3 mm long. Sepals 5, broadly ovate, obtuse at apex, *c.* 1 mm long, green, valvate. Petals 5, oblong, obtuse at apex, concave, *c* 3 mm long, pale green, valvate. Stamens 5; filaments short, *c.* 1 mm long, inserted in disk, curved down when mature; anthers globose. Ovary immersed in cushion-like disk; style short, conical, stigma simple. Drupes oblong, *c.* 2 cm long, greenish.

Fl. & Fr.: January - ?

Habitat: Coastal scrub jungle, on sandy soil, under shade of *Acacia planifrons* trees; rare, only about 10 plants seen.

Distribution: Sri Lanka and southern India (Tamil Nadu).

Notes: The Sri Lanka plant is a tree, up to 20 m tall and up to 90 cm dbh, older trees massive and the leaves shallowly and remotely serrate. However, under *Note* Kostermans (1986 : 186) stated that in northeast Sri Lanka on dunes and sterile sandy coastal areas, the plant is a many-short-boled bushy shrub. Its leaves are sharply serrated along margins, and he never saw it in flower. The Indian plant has similar habit and leaves. It was also found to occur in a sterile sandy coastal area under the shade of *Acacia planifrons* trees which are almost ubiquitous throughout the Gulf of Mannar coast in Tamil Nadu. Despite our continuous monitoring for almost three years, we managed to collect material in flower and fruit only once. The factors that govern flowering and fruiting in this habitat on either side of the Gulf of Mannar need further investigation.

The putamen splits into two halves after a prolonged period of soaking and rotting (Kostermans, 1986). The fruits are green to boot, and unlikely to be picked up by birds, so the seeds might have reached the Indian shores by seawater. That the plant might have reached India through a human agency (the Tamil refugees from Sri Lanka) may not be ruled out.

Specimens examined: INDIA. Tamil Nadu, Ramanathapuram dist., Mandapam Camp, CMFRI Campus, under *Acacia planifrons* trees, on loose sandy soil, 10.i.1996, P. Daniel & P. Umamaheshwari 106696 (MH). Kalpituya, Jan. 1882, C.D. Vigros s.n. (PDA photocopy!).

ACKNOWLEDGEMENTS

We thank the Director, BSI, Calcutta, for facilities and Dr. U. Dhanasekera, Curator (PDA), for confirming the identity of our material and sending photocopies of a paratype and the other specimen cited. The junior authors thank the Ministry of Environment and Forests, Govt. of India, for a fellowship.

June 13, 1998

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REFERENCE

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31. OCCURRENCE OF *GONIOPHLEBIUM AMOENUM* (WALL. EX METT.) J.SM. IN BIHAR

While exploring the flora of Singhbhum dist., Bihar during 1993-94, we collected a specimen of *Goniophlebium amoenum* (Wall. ex Mett.) J.Sm. at Meghahatuburu (1200 m above msl). A critical review of the existing literature (Haines 1924; Mooney 1950; Chowdhury 1973 and Dixit 1984) reveals that this species has not so far been recorded from the state and is being reported for the first time.

Goniophlebium amoenum (Wall. ex Mett.) J.Sm. in Hook. Gen. Fil. t.51.1840; Bedd. Ferns Brit. India t. 5. 1965; Handb. Ferns Brit. India 317. 1883. *Polypodium amoenum* Wall. ex Mett. Abh. Senckneb. Naturf. Ges. 2: 80.1857.

Lamina devoid of stellate hairs, glabrous or sparsely scaly, simple to pinnate. Veins forming regular rows of areoles along either sides of costae, free outwards, included veinlets solitary, simple, lamina pinnatisect, lowest pair of pinnules slightly reduced, deflexed downwards; rachis sparsely scaly on ventral surfaces; sori at the tip of included veinlets, biseriate along the costae.

The plant was an epiphyte as well as rarely growing on the forest floor.

Specimen examined: Bihar, Singhbhum district, Meghahatuburu (1200 m), S.N. Basu. The specimen is deposited in the Department of Botany, Ranchi University, Ranchi.

June 13, 1998

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32. ON THE OCCURRENCE OF *UTRICULARIA BRACHIATA* OLIVER (LENTIBULARIACEAE) IN GARHWAL HIMALAYA

(*With one text-figure*)

During routine plant collections from remote localities of Garhwal Himalaya, we collected a few specimens of the genus *Utricularia* from Rudranath area, Chamoli dist.

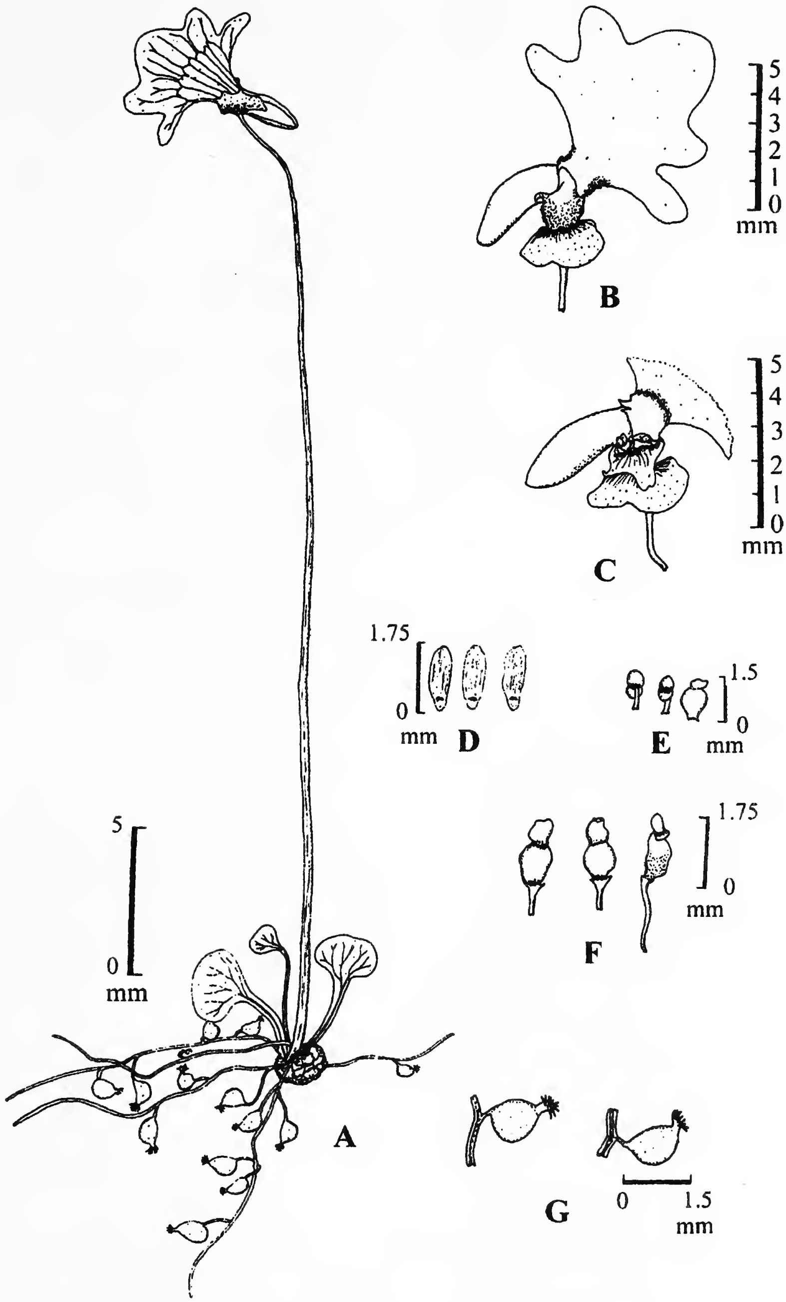

Fig. 1: A. flowering plant, B. flower, C. flower partially dissected to show stamen and carpel, D. bracts and bracteoles, E. stamen and carpel, F. carpel from different angles, G. traps.

After a thorough checking of the specimens at the herbarium of Forest Research Institute, Dehra Dun and study of recent literature on Indian *Utricularia* (Janarthanam and Henry 1992; BLADDERWORTS OF INDIA) they proved to be the extremely rare species *U. brachiata* Oliver, hitherto unrecorded from Western Himalaya.

The species was considered as endemic to the Eastern Himalaya 2400 m above msl and was described from Sikkim by Oliver, with one sheet having three specimens collected in 1849. Later it was collected from Zemu Valley of Sikkim in 1909 and from Suburkum, West Bengal in 1906. After these collections, the species has not been collected from Indian territory. It is meagrely represented in herbaria (Janarthanam and Henry 1992). The present collection of this species from Garhwal Himalaya is of phytogeographical interest, and indicates the range of variation in its morphology. The stamens and pistil are described and drawn here for the first time.

A short description of the species, and illustrations have been provided to facilitate further collection and easy identification. The voucher specimens are deposited in the Herbarium of the Department of Botany, H.N.B. Garhwal University, Srinagar, U.P., India (GUH) and Central National Herbarium, Calcutta. (CAL).

Utricularia brachiata Oliver in J. Proc. Linn. Soc. Bot. 3: 189. 1859; Clarke in Hook. f. Fl. Brit. India 4: 333. 1884; Smith and Cave in Rec. Bot. Surv. India 4: 230. 1911; Smith in Rec. Bot. Surv. India 12: 117. 1938; Basak in Bull. Bot. Surv. India 17: 105. 1975 (1978); Taylor in Hara *et al.*, Enum. Fl. Pl. Nepal 3: 132. 1982; Taylor in Kew. Bull. Add. Ser. 14: 462. 1989; Janarthanam and Henry, Bladderworts of India 41. 1992.

Small, slender, delicate herb, 2.0-5.0 cm long, with a tuber at the base. Stolons spreading, unbranched. Foliar organs 2-3, rosulate; expanded portion *ca.* 2.0-3.0 mm, orbicular. Traps on stolons ovoid, mouth lateral with radiating hairs. Racemes 1-2 flowered. Flowers white with hairy yellow throat. Stamens 2, 1.0-1.75 mm, attached very close to pistil on upper lip; filament strap-shaped, usually obscurely twisted; anther smaller than filaments, thecae obscure, usually touching the stigma. Pistil equal to stamen, 1.5-2.0 mm; ovary ovoid, ovules numerous on axile flask-shaped placenta; style much reduced, thick; stigma bilipped, spreading, larger lip oblong-ovate (Fig. 1A-G).

Flowering: July-August.

Distribution: Nepal, Bhutan, southwest China. In India recorded from Arunachal Pradesh, Sikkim, West Bengal. For the first time collected from Western Himalaya (Garhwal) by the authors.

Habitat: In the Himalaya, more than 2,400 m above msl, epiphytic on moss covered trunks; present collection from a moss covered, moist, vertical rock face.

Material examined: INDIA, Sikkim, Zemu Valley, 23.vii.1909, Smith and Cave, 1733 (DD); India, U.P. Garhwal Himalaya, Rudranath alpine zone (Chamoli dist.), 3300 m above msl ?.vii.1995 D.S. Rawat, 26201 (GUH).

ACKNOWLEDGEMENTS

We thank Dr. M.K. Janarthanam, Goa University and Dr. A.N. Henry, ex-Jt. Director Southern Circle, BSI, Coimbatore for confirming the identification, and the authorities of Forest Research Institute, Dehra Dun for herbarium facilities.

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33. A TAXONOMIC ACCOUNT OF *ROBIQUETIA* GAUD. (ORCHIDACEAE) FROM BANGLADESH

(*With two text-figures*)

Robiquetia is an epiphytic Orchidaceous genus of about 20 species, distributed in India, southeast Asia, Malaysia, Solomons and Fiji (Airy-Shaw 1973, Hunt and Grierson (1973). Only two species *R. succisa* (Lindl.) Seidenf. & Garay and *R. spathulata* (Bl.) J.J. Sm. have been reported from India by Pradhan (1979). He mentioned that *R. succisa* (Lindl.) Seidenf. & Garay was also found in Bangladesh. Jayaweera (1981) recorded four species from Sri Lanka. On the other hand, Hooker (1890) included the genus under *Saccolabium* and reported *R. succisa* (Lindl.) Seidenf. & Garay from the Sylhet area now in Bangladesh. So far no systematic study has been done on the genus in Bangladesh. The present work is a study of this genus from Bangladesh. One more species *Robiquetia spathulata* (Bl.) J.J. Sm., is reported from Bangladesh as a new record.

The preserved and living specimens are housed in the Botany Department Herbarium and Orchidarium respectively, at Chittagong University, Chittagong, Bangladesh.

Key to the species of ***Robiquetia***

1. Leaves 12.0-20.0 cm long and 3.0-5.0 cm broad, inflorescence regularly simple and ± 20.0 cm long .... *R. spathulata*
1. Leaves 6.5-9.0 cm long and 1.0-2.0 cm broad, inflorescence often branched and ± 10.0 cm long .... *R. succisa*

Enumeration of the species

1. ***R. spathulata*** (Bl.) J.J. Smith. Smith, J.J. Bull. Jard. Bot. Buitenzorg 2. Ser. 8. (1912), *In* Pradhan, Ind. Orch., 2: 554 (1979). Syn. *Cleisostoma spathulatum* Bl. Blume. C.L. Bijdragen tot. de Fl. van Nedert. Indie-Batavia. 434 (1825), *In* Pradhan, Ind. Orch., 2: 631 (1979); *C. spicatum* Lindl. in Bot. Reg. t. 32 (1847); Hook. f. Fl. Brit. Ind., 6: 72 (1890); Grant, Orch. Burma, 311 (1895); Bruhl, Orch. Sikkim, 138 (1926); Bose & Bhattacharjee, Orch. Ind., 148 (1980); *Saccolabium densiflorum* Lindl. Gen. & Sp. Orch., 220 (1833). (Fig. 1)

Inflorescence rarely branched and is one of the long lasting inflorescences where flowers are continuously blooming for about two months. The species is very similar to Pradhan's (1979) descriptions and drawings. Flowers 8 x 8 mm across, yellow with reddish-brown patches on the outer side. Sepals subequal, broadly elliptic. Petals connately obovate. Lip yellowish, adnate wholly to sides of the column and ending in an infundibular spur, dilated, compressed and 3-notched at the apex; side lobes obscurely erose, obtuse and rounded; midlobe thick, triangular-ovate; interior of spur contracted at two points by calli in front and back walls, the back wall callus divided into 2 recurved teeth. Pollinia 2, 0.5 x 0.5 mm, globular, bipartite, attached with 2 mm long slender strap and a small sagittate viscidium. Stigmatic surface 0.5 x 0.5 mm. Capsule not found. Flowering scape initiation: mid April.

Fl.: Mid May-late July

Fr.: Unknown.

Geographical distribution: Throughout Southeast Asia including Bangladesh.

Material examined: Cox's Bazar dist. Ramu, Dechua palong, 13.x.1986 (collected at vegetative stage, subsequently flowered next year, cultured in Orchidarium), Mokter 56; Ukhia, Kotopalong, 20.x.1986, Mokter, 67.

2. ***R. succisa*** (Lindl.) Seidenf. & Garay. Seidenfaden & Garay, Contrb. Orch. Fl. Thai. 4. Bot. Tidsskr. 67, (1972), *In* Pradhan, Ind. Orch., 2: 553 (1979) Basionym of Lindl. *Saccolabium buccosum* Reichb. f. in Gard. Chron., 938 (1871);

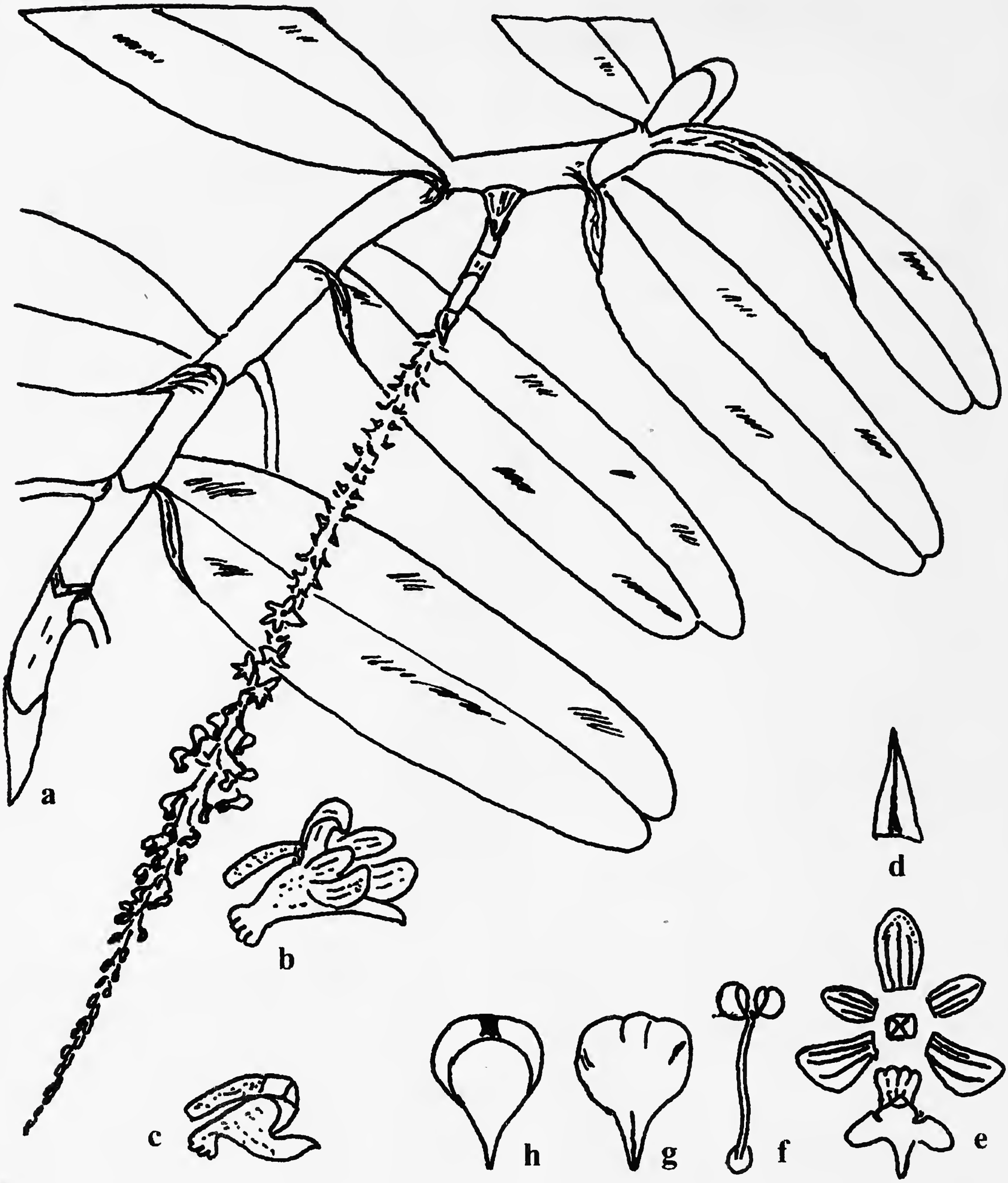

Fig. 1: *Robiquetia spathulata* (Bl.) J.J. Sm.: (a) habit with inflorescence (x 1/2); (b) flower from semi-side (x 2); (c) pedicellate ovary, column and lip from semi-side x 2); (d) floral bract (x 3); (e) sepals, petals and lip spread out, column from inside (x 2); (f) pollinia (x 10); (g) operculum from front (x 10); (h) operculum from inside (x 10).

Fig. 2: *Robiquetia succisa* (Lindl.) Seidenf. & Garay: (a) habit sketch with inflorescence (x 1); (b) pedicellate ovary, column and lip from side (x 2); (c) floral bract (x 3); (d) sepals, petals and lip spread out (x 3).

Hook. f. Fl. Brit. Ind., 6: 58 (1890); Bruhl, Orch. Sikkim, 135 (1926); Bose & Bhattacharjee, Orch. Ind., 472 (1980). (Fig. 2)

The species was collected by Moyeen from Kaptai forest of Chittagong Hill Tracts, Bangladesh, growing as an epiphyte on *Tectona grandis* L. f. I carefully examined this single specimen preserved in the herbarium of the Botany Department, Chittagong University, Chittagong, which closely matches Pradhan's (1979) description and drawings. Unfortunately, I could not find the operculum and pollinia in

the dry specimen. Flowers yellowish-red. Sepals subequal, broadly ovate. Petals slightly smaller than sepals, cuneately obovate. Lip 3-lobed with bottle-shaped spur at the base, apex of the spur globose, didynamous; side lobes rounded and midlobe oblong. Stigmatic surface 1 x 1 mm. Capsule not seen.

Fl.: Late June-late July

Fr.: Unknown.

Geographical distribution: India, Assam, Sikkim, Bangladesh, Bhutan and Thailand.

Specimen examined: Chittagong Hill Tracts (Ragamati); Kaptai, 10.ii.1981 (collected at vegetative stage, subsequently flowered next year, cultured in the Botanical garden, Chittagong University, Chittagong, Bangladesh), Moyeen 404.

April 22, 1998

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34. *BOLBOSCHOENUS PLANICULMIS* (F. SCHMIDT) T. KOYAMA (CYPERACEAE) — A NEW RECORD FOR SOUTH ASIA FROM GUJARAT COAST

(*With two text-figures*)

While working on Cyperaceae specimens from the West Coast of the country, two interesting specimens were found labelled as *Scirpus maritimus* L. var. *affinis* Clarke. As some striking, superficial differences were found in these specimens, a detailed study was made and the specimens were subsequently identified as *Bolboschoenus planiculmis* (Schmidt) Koyama which is not yet reported from India and the neighbouring countries, except from the Chinese coast. A detailed description of the species along with illustrations and distribution is given below.

Bolboschoenus planiculmis (F. Schmidt) T. Koyama, Fl. Taiwan 5: 207. 1978. *Scirpus planiculmis* F. Schmidt, Reisen Amerlande U. Ins. Sachalin 190, t. 8, f. 1-7. 1868; Koyama in Journ. Fac. Sci. Univ. Tokyo 3, 7(6): 330, f. 13. 1958. Fig. 1.

Perennials with long stolons, 30-50 cm high, stramineus when dry. Stolons slender, 1-1.5 mm thick, covered by brownish sheaths, ending in small tubers; tubers ovoid to oblong-ellipsoid, 10-12 x *ca* 3 mm, rooting and producing new stems. Stems solitary from the

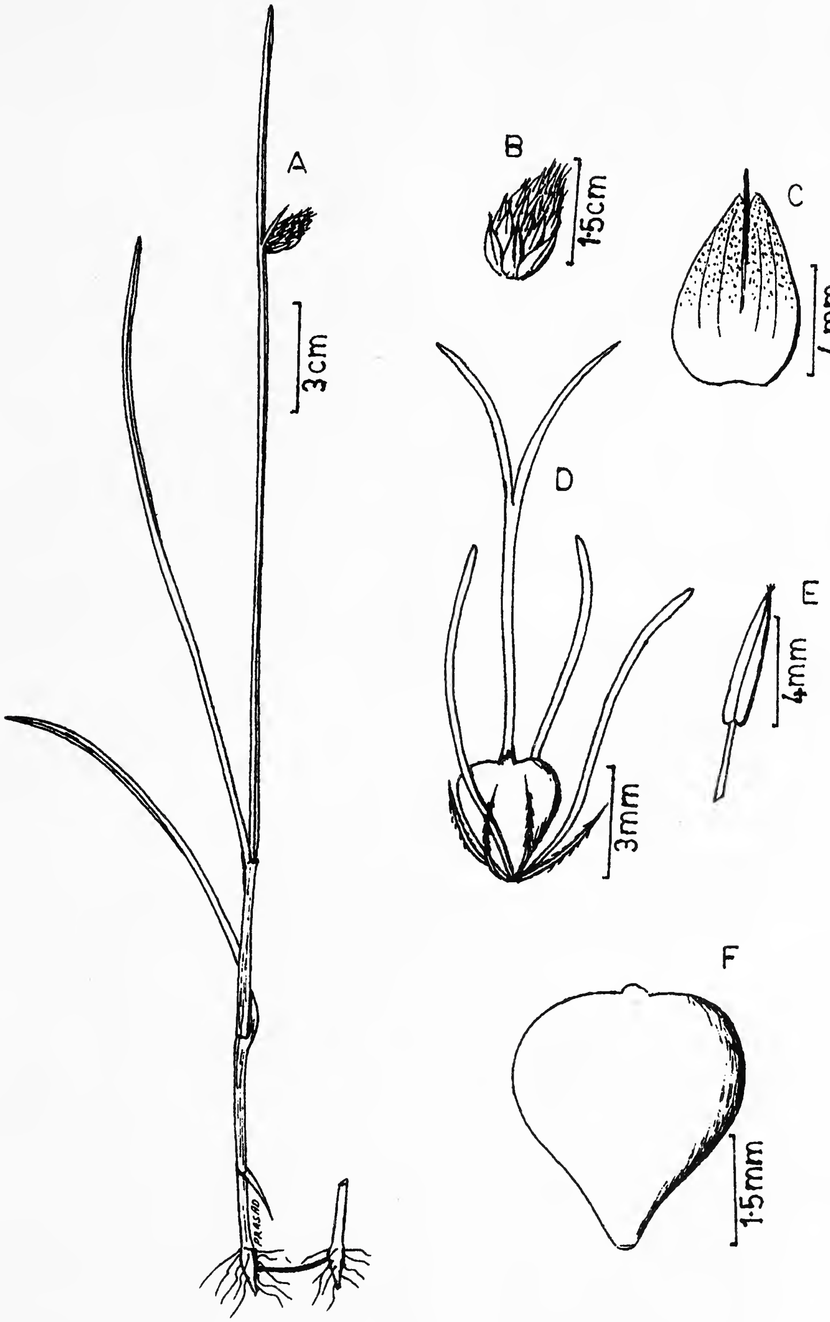

Fig. 1: *Bolboschoenus planiculmis* (Schmidt) Koyama (A) Habit; (B) Spikelet; (C) Glume; (D) Flower in later stage; (E) Stamen; (F) Nut.

tuberous base, narrow, erect, trigonous with flat sides, 1-2 mm thick in the middle portion, nodose towards base, striate, glabrous, few-leaved in the basal half. Leaves cauline, shorter than stem, triangular, almost 3-winged towards apex, linear, acute at apex, 1.5-2 mm wide; basal leaves almost bladeless; sheaths tightly closed, truncate at mouth; ligule absent. Inflorescence a single pseudolateral spikelet. Involucral bracts 1 or 2; main bract erect, as if continuation of the stem, trigonous, 7-15 cm long; smaller one 1.5-4.5 cm long, flat. Spikelets ovoid to broadly ovoid, subacute at apex, 8-20 x 6-10 mm, ferrugineus, densely flowered. Glumes scarious, broadly ovate, emarginate at apex, *ca* 8 x 4-6 mm, puberulous in the upper half; midrib very prominent, extending to a long awn; side veins 0-4. Perianth bristles 4-6, slender, unequal, shorter than or overtopping the nut, retrorsely scabrous.

Stamens 3; filaments flat, hyaline, elongate up to 8 mm; anthers linear, oblong-lanceolate, with a prominent bristly connective appendage at apex, 4-5 mm long. Style *ca* 4 mm long, slightly narrowed to base; stigmas 2, 2.5-3 mm long. Nuts planoconvex, broadly obovate, cuneate to base, apiculate at apex, 3.5-4.5 x 2.5-3 mm, smooth, creamish-brown to blackish brown; epidermal cells isodiametric, usually not clearly visible in mature nuts.

Fl. & Fr.: October

Habitat: Seashore.

Distribution: So far reported in East and Far East Asia, from the coasts of China, Taiwan, Korea, Japan (including Ryukyus Archipelago) and Sakhalin. Therefore, its present report from south Asia (Gujarat coast in western India) is phytogeographically interesting.

Specimen examined: Aliahet-Hansot, Gujarat, *Toor* 25817. 18.x.1957 (BSI).

According to Koyama (loc. cit), *Bolboschoenus planiculmis* varies in the number of spikelets and also in the shape and size of the nuts, though it is clearly distinct from the closely related, *B. maritimus* complex especially to the subspecies *affinis* (Roth) Koyama. The differences between these two taxa are based on the Indian specimens available in BSI.

B. planiculmis can be distinguished easily by its pseudolateral inflorescence of a single

B. maritimus ssp. *affinis* (Roth) Koyama	*B. planiculmis* (Schmidt) Koyama
Stolons thick and woody	Stolons slender, not woody
Tubers stout, 10-25 x 6-9 mm.	Tubers thin, 10-12 x *ca* 3 mm.
Stems 2.5-6 mm thick near the base (including the sheaths).	Stems 1.5-3 mm thick near the base (including the sheaths).
Leaves flat, 2.5-5 mm wide.	Leaves triangular, 1.5-2 mm wide.
Inflorescence a terminal cluster of 2-6 sessile spikelets, at times reduced to a single spikelet.	Inflorescence a single, pseudolateral spikelet.
Involucral bracts 2-3, flat, foliaceous.	Involucral bract 1 or 2; the main bract trigonous, looks like continuation of the stem.
Glumes oblong-lanceolate, 7-10 x 2.5-3 mm; side veins usually absent.	Glumes broadly ovate, *ca* 8 x 4-6 mm; side veins 0-4.
Perianth bristles shorter than the nut.	Perianth bristles shorter than or overtopping the nut.
Staminal filaments elongate up to 6 mm; anthers oblong, *ca* 2 mm long.	Staminal filaments elongate up to 8 mm; anthers linear or oblong-lanceolate, 4-5 mm long.
Style *ca* 2 mm long.	Style *ca* 4 mm long.
Nuts *ca* 2.5 x 2 mm.	Nuts 3.5-4.5 x 2.5-3 mm.

spikelet and triangular nature of the leaves and the main bract. Slender stolons which are not woody, also characterise the species. Moreover, it is found only along seashores.

ACKNOWLEDGEMENTS

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March 18, 1998

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ERRATA

Vol. 96, No. 1, April 1999, read the following graph

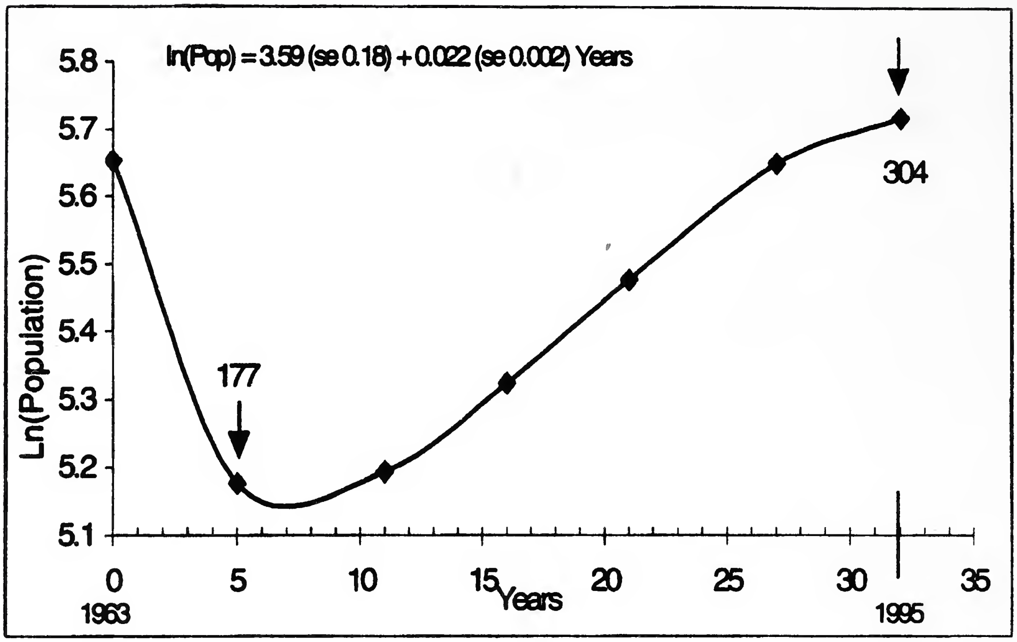

Fig. 2: Trends in the lion *total counts* in Gir between 1963 to 1995. The inset reports regression results for log transformed *total counts* between 1968 and 1995

Vol. 96, No. 1, April 1999 p. 14 Acknowledgements:
The name of J.D. Nicholson was inadvertently omitted

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